

INSTRUCTIONS AND APPLICATIONS

Vibration Meter Type 2502 Control Signal Selector Type 4410 Vibration Programmer Type 4411



With the Vibration Meter Type 2502 and auxiliary instruments Type 4410 and 4411 a variety of possibilities have been created for automatic programming of sweep-sine and sweep narrow band random vibration testing. The new development entails control from up to four accelerometers simultaneously, on an average, highest, or lowest basis, and a break up of the test frequency range into six continuously adjustable frequency sub-ranges with individual function control in each range.

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Accelerometers
Acoustic Standing Wave Apparatus
Artificial Ears
Artificial Voices
Audio Frequency Response Tracers
Audio Frequency Spectrometers
Audio Frequency Vacuum-Tube Voltmeters
Automatic A. F. Response and Spectrum Recorders
Band-Pass Filter Sets
Beat Frequency Oscillators
Complex Modulus Apparatus
Condenser Microphones
Deviation Bridges
Distortion Measuring Bridges
FM-Tape Recorders
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Hearing Aid Test Apparatus
Heterodyne Voltmeters
Level Recorders
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Mobile Laboratories
Noise Generators
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Pistonphones
Polar Diagram Recorders
Preamplifiers
Precision Sound Level Meters
Recording Paper
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Stroboscopes
Variable Frequency Rejection Filters
Vibration Pick-ups
Vibration Pick-up Preamplifiers
Wide Range Vacuum Tube Voltmeters
Vibration Programmers
Vibration Control Signal Selectors
Vibration Control Generators
Vibration Meters



Vibration Meter

Type 2502

Control Signal Selector

Type 4410

Vibration Programmer

Type 4411

October 1967

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1. Introduction

With the Vibration Meter Type 2502 and auxiliary instruments Type 4410 and 4411 a variety of possibilities have been created for automatic programming of sweep-sine and sweep narrow band random vibration testing. The new development entails control from up to four accelerometers simultaneously, on an average absolute, highest, or lowest basis, and a break up of the test frequency range into six continuously adjustable frequency sub-ranges with individual function control in each range.

As test specimens become larger and more complex, the vibration test engineer finds that the single accelerometer feedback control is inadequate. A multiple input test system in general has different mechanical impedances at the different input points, whereby differences in motion will occur. Fixture design aims at avoiding these differences but is seldom completely successful. Large differences in motion often occur from input point to input point, and a one accelerometer control system results in overtesting or undertesting in important frequency ranges.

One way of reducing overtesting is to use as feedback signal an average of the vibration signals from the input points. If the averaging is done on an RMS basis this reduces the overtesting to a factor less than n , where n is the number of input points. Using for example four accelerometers at four input points will reduce overtesting to less than 12 dB. Undertesting will only be slightly affected.

If a further reduction of overtesting is found necessary, this can be done by switching circuits automatically selecting the largest of the signals from the measuring points. Overtesting is thereby reduced to zero. Undertesting is not remedied.

Undertesting due to different motion at input points can similarly be eliminated by selecting the smallest of the vibration signals for feedback. This procedure does not necessarily affect overtesting.

The equipment described in this book has facilities for feedback control via the average, the highest or the lowest of up to four accelerometer signals, using the average value of the signals as a basis for control.

As test specifications become more exacting with regard to excitation versus frequency characteristic, it is found desirable to have more possibilities of varying the slope of the characteristic over the frequency sweep. So far only one cross-over has been available, with cross-over from constant displacement to constant acceleration etc., at a preselected frequency.

The equipment described in this book gives five adjustable cross-over points, with a variety of functions to choose from in each frequency sub-range, including an external filter facility. Thus any excitation versus frequency characteristic can be obtained for sweep sine and sweep narrow band random vibration tests.

2. Programming System

In order to describe the functioning of the various instruments covered by this manual it is perhaps best to start with a complete set-up, so that the purpose of the various instruments is clarified. Such a set-up is shown in Fig. 2.1.

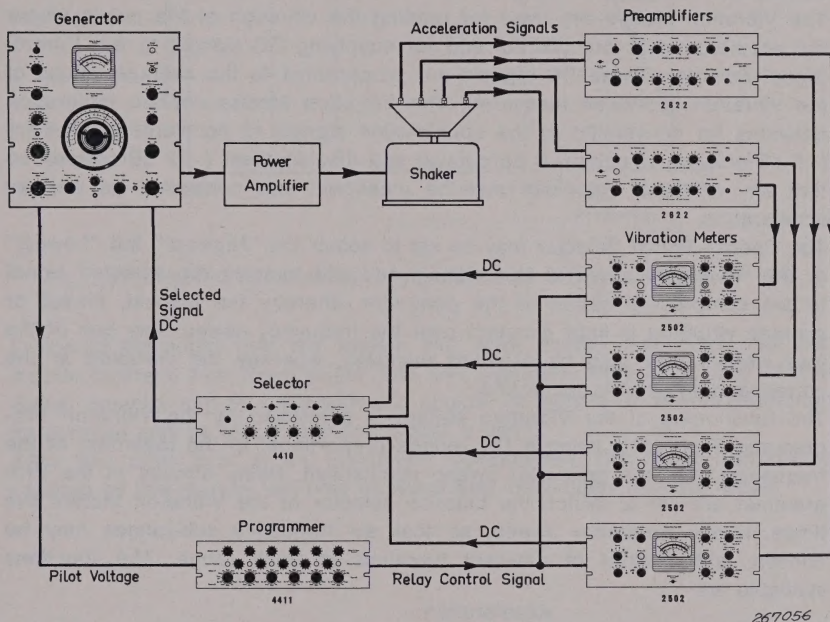


Fig. 2.1. Complete vibration test set-up.

It should be noted that this is a fairly complex system, utilizing all the instruments. Such a powerful set-up is not required for all types of applications. Some may only need the simple 2622 - 2502 - 1042 combination (or 2622 - 1025). The various possible instrument combinations are described fully in Chapters 6, 7, 8, 9, 10, and 11.

Returning to Fig. 2.1 it is seen that the excitation signal to the shaker is supplied by a generator Type 1042 or 1025 via a power amplifier. Type 1042 supplies a sweep sine or a sweep narrow band random signal in the frequency range 5 Hz to 10000 Hz while Type 1025 has a sinusoidal output only. The sweep is automatic and the output signal is regulated by a feedback signal

derived from the acceleration measured on the shaker table or on the specimen being tested. When the Control signal Selector Type 4410 is employed, it is possible to control the vibration from up to four accelerometers simultaneously. Suitable accelerometers are the B & K Piezoelectric Accelerometers Type 4332-40.

Accelerometer Preamplifiers Type 2622 are used for impedance conversion of the high impedance signals from the accelerometers. A separate instruction book is issued for the Preamplifier, where a more thorough description is given, suffice it here to say that it is a two-channel preamplifier which may be switched to operate as a charge amplifier or as a voltage amplifier, and that its outputs are scaled to 10 mV/g.

The Vibration Meters are used for reading the vibration at the points where the accelerometers are placed, and for supplying DC signals to the Control Signal Selector. These DC signals are proportional to the average values of the vibration quantities measured. The Vibration Meters contain integration networks for conversion of the acceleration signals to acceleration gradient (-3 dB/octave), velocity (-6 dB/octave) and displacement (-12 dB/octave), so that any of these quantities may be measured and controlled as well as acceleration.

The Control Signal Selector may be set to select the "Highest", the "Lowest" or the "Average" of up to four signals and will transmit the selected signal to the compressor circuit of the generator whereby the highest, lowest or average vibration is kept constant over the frequency sweep. Any one of the four signals may also be selected manually, whereby the vibration at the corresponding point is controlled.

The functioning of the Vibration Meters is controlled by the Vibration Programmer Type 4411, using a DC voltage proportional to the logarithm of the frequency from the generator sweep mechanism. Relay circuits in the Programmer are set to switch the function selector of the Vibration Meters five times in any frequency sweep, so that six frequency sub-ranges may be chosen, with control of different functions in each range. The functions available are

- Acceleration
- Acceleration Gradient
- Velocity
- Displacement
- External Filter

and a 20 dB sensitivity reduction for each function. The required function is individually pre-selected for each frequency sub-range and any combination of functions is possible.

The built-in weighting networks will be found sufficient for most applications, but for special frequency characteristics the external filter facility is a convenient feature.

An example of a combination of functions for a frequency sweep is shown in Fig. 2.2.

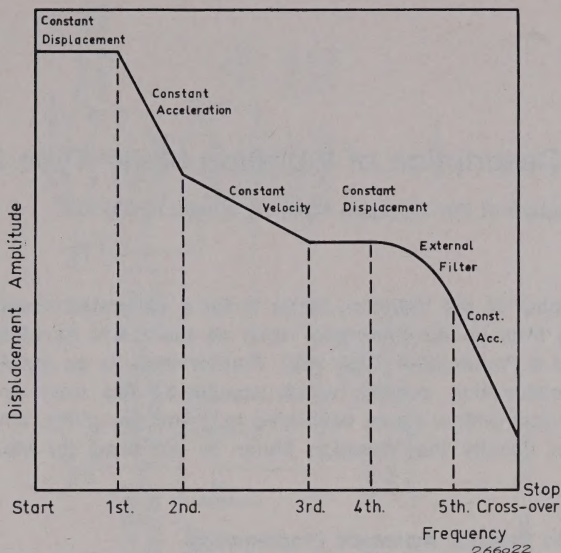


Fig. 2.2. Possible combination of functions for a frequency sweep test.

It should be noted that the system will work equally well with only two Accelerometers, one Preamplifier and two Vibration Meters, as the Control Signal Selector can be used with any number of signals up to four (Although its purpose may be lost if only one signal is used).

After this brief look at an instrument combination, the three instruments covered by this manual will now be described individually in more detail.

3. Description of Vibration Meter Type 2502

A block diagram of the Vibration Meter is shown in Fig. 3.1.

3.1. Inputs.

The main input of the Vibration Meter is for a calibrated acceleration signal of 10 mV/g from an accelerometer such as the B & K Accelerometers Type 4332-35 and a Preamplifier Type 2622. Further there is an input for measurement of acceleration density, which should be fed from an acceleration density analyzer with a signal calibrated to 1 volt per g^2/Hz . When measuring acceleration density the Vibration Meter is not used for vibration control purposes.

3.2. Function Selector Automatic Programming.

Switching of the Function Selector can be done remotely or manually. Automatic programming of up to six frequency sub-ranges is available when the Vibration Meter is used with the Vibration Programmer Type 4411. When used without the Programmer, only one cross-over is available, governed by a cross-over switch on the frequency sweep mechanism of the generator.

The available functions are then

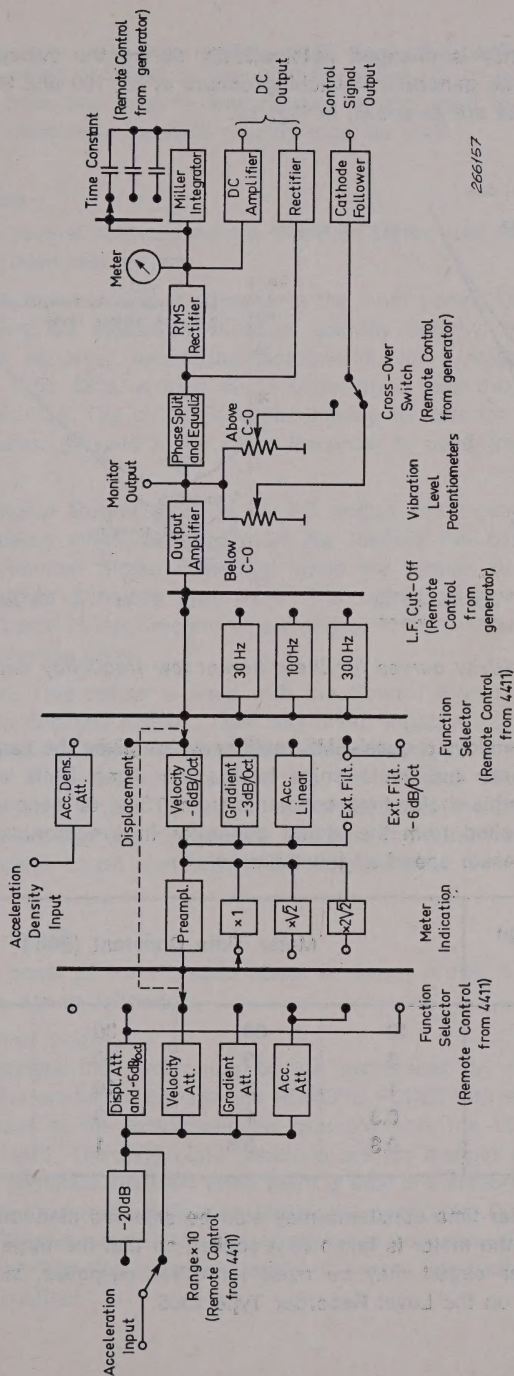
- Displacement to Acceleration
- Velocity to Acceleration
- Acceleration to Acceleration Gradient

Any other combination may be obtained by appropriate short-circuiting between the RELAY CONTROL and CROSS-OVER terminals at the back of the instrument.

The functions "Displacement", "Velocity", "Acceleration Gradient", "Acceleration" and the linear "External Filter" function together with a 20 dB sensitivity reduction for each, can all be remotely operated from the Vibration Programmer. It is thus possible in one sweep to have up to six different functions and to have up to 40 dB differences in level within the frequency range of each function.

3.3. Low-frequency Cut-off.

A variable low-frequency cut-off is included to give an optimum signal to noise ratio. It is important to cut off as much as possible of the low-frequency end of the frequency range, especially when integration networks are employed, since these emphasize low frequency signals.



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Fig. 3.1. Block diagram of the Vibration Meter.

The cut-off frequency is changed automatically during the sweep by relay control circuits in the generator. Switching occurs at 30, 100 and 300 Hz and the sensitivity curves are as shown in Fig. 3.2.

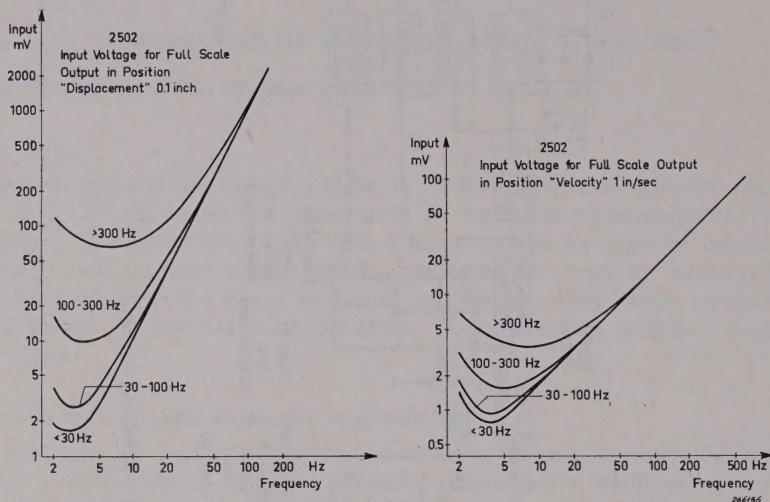


Fig. 3.2. Sensitivity curves for the different low frequency cut-offs.

3.4. Meter Circuit.

The meter circuit employs a quasi-RMS rectifier which gives the same reading for sinusoidal signals and white noise having the same RMS value. Four programs of selectable meter time constants from 0.3 to 30 seconds can be automatically controlled from the signal generator in synchronism with the changing of compressor speed as tabulated below:

Frequency Range (Hz)	Meter Time Constant (Sec.)			
Below 30	10	30	30	30
30 - 100	3	10	30	30
100 - 300	1	3	10	30
300 - 1000	0.3	1	3	10
Above 1000	0.3	0.3	1	3

Any one of the meter time constants may also be selected manually. The DC voltage to the meter is taken to a socket, so that the large time constants of the meter circuit may be used for other purposes, such as for example recording on the Level Recorder Type 2305.

The meter is calibrated to indicate RMS, peak and peak-to-peak values, the latter two being obtained by changing the sensitivity by a factor $\sqrt{2}$ and $2\sqrt{2}$. Thus the peak and peak-to-peak reading is only valid for sinusoidal signals. For other waveforms the RMS reading must be used.

3.5. Outputs.

There are several outputs from the Vibration Meter used for different purposes in the vibration test system.

Monitor. A monitor jack is situated in the front panel. This is an AC output representing the measured vibration quantity directly. It may be used for earphones or other monitoring instruments, for example the B & K Level Recorder Type 2305. A load of 15 kohm gives less than 1 % error on the meter indication. The output is approximately 10 volts for full scale deflection on the meter. (5 volts if the Level Recorder is used (output impedance 18 kohm)).

Control Signal Output. This is an AC output proportional to the vibration quantity being measured, and used for feeding the compressor circuit of the Sine-Random Signal Generator when the system does not include the Control Signal Selector Type 4410. The output voltage is scaled by the Vibration Level Potentiometers below and above cross-over, for setting of the desired vibration level.

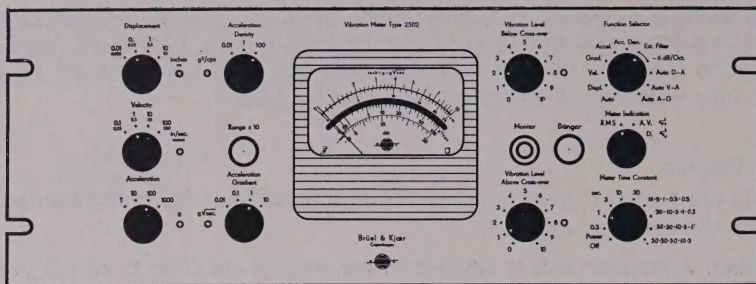
DC Output. This output is used with the Control Signal Selector Type 4410. It contains two DC signals: One smoothed, negative signal, -6.5 V for full scale deflection, and one unsmoothed negative signal, 7 V peak for full scale deflection. These signals are taken to the selector circuits of the Control Signal Selector, whose DC output is connected to the compressor circuit of the generator, after the compressor rectifier. The meter rectifier is linear from 20 dB below to 12 dB above full scale deflection.

3.6. Front Panel.

The front panel of the Vibration Meter is shown in Fig. 3.3. The sockets and knobs etc. are as follows:

Function Selector.

Determines the functioning of the instrument. In position "Auto" the function control is through the REMOTE FUNCTION SELECTOR socket at the back of the instrument, for example from the Vibration Programmer Type 4411. The next eight positions are for manual control and the last three positions are used when there is only one cross-over point, governed by the cross-over switch on the signal generator. D-A means cross-over from "Displacement" to "Acceleration" at the cross-over point, V-A means "Velocity" to "Acceleration" and A-G means "Acceleration" to "Acceleration Gradient".



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Fig. 3.3. Front panel of the Vibration Meter.

Meter Indication.

Controls RMS or Peak-to-peak indication. RMS position to be used when the vibration is not sinusoidal.

Meter Time Constant.

On-Off switch for power and control switch for meter time constant. Manually selectable constants from 0.3 to 30 seconds. Four automatic programmes controlled from the generator as tabulated on page 12.

Danger.

The warning lamp indicates with a red light that the compressor is operating and that the setting of the control knobs with red spots should not be altered. If the position of these knobs is altered when the lamp is alight violent changes in the vibration level can occur, which may damage the test specimen or the vibration system itself. Identical warning lamps may be built-in in other instruments in the complete vibration system.

Vibration Level below Cross-Over.

Potentiometer for setting of the vibration level below the cross-over point when the automatic cross-over governed by the generator is used.

Monitor.

Jack for monitoring the vibration signal using for example a level recorder or earphones.

Vibration Level above Cross-Over.

Potentiometer for setting of the vibration level above the cross-over frequency when the single cross-over facility is used.

Acceleration Density.

Attenuator for setting of the measuring range for acceleration density measurements, in connection with the acceleration density input at the back of the instrument.

Range X 10.

Light indicating that the measurement and control range is 10 times that indicated by the range switches, i.e. there is an extra 20 dB attenuation in the circuit.

Acceleration Gradient.

Attenuator switch controlling the measurement and control range of the instrument when the FUNCTION SELECTOR is set to "Grad". The figures 0.01 --- 10 g/ $\sqrt{\text{sec}}$ correspond to full scale deflection on the meter.

Displacement.

Attenuator switch controlling the measurement and control range of the instrument when the FUNCTION SELECTOR is set to "Displ". The figures 0.01 --- 10 inches or 0.25 --- 250 mm correspond to full scale deflection on the meter, RMS or Peak-to-peak as determined by the METER INDICATION switch.

Velocity.

Attenuator switch controlling the measurement and control range of the instrument when the FUNCTION SELECTOR is set to "Vel". The figures 0.1 --- 100 in/sec or 0.0025 --- 2.5 m/sec correspond to full scale deflection on the meter, RMS or Peak as determined by the METER INDICATION switch.

Acceleration.

Attenuator switch controlling the measurement and control range of the instrument when the FUNCTION SELECTOR is set to "Accel". The figures 1 --- 1000 g correspond to full scale deflection on the meter, RMS or Peak according to the setting of the METER INDICATION switch.

3.7. Rear Panel.

The rear panel of the Vibration Meter is shown in Fig. 3.4. The various sockets are as follows:

Control Signal Output.

7-pin socket (Cannon WK-A7-32S) for the AC output signal used in the combination 1042 - 2502. Pin 1: Signal. Pin 4: Ground.

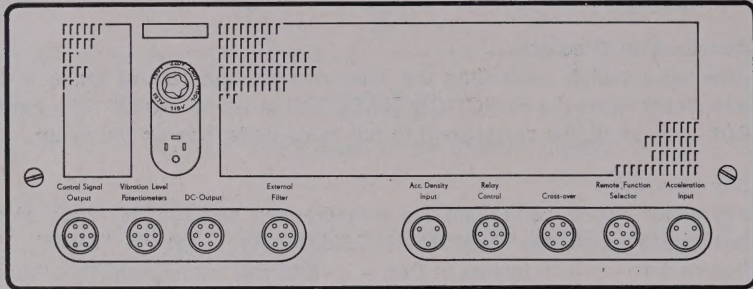
Vibration Level Potentiometers.

7-pin socket (Cannon WK-A7-32S) connected to the vibration level potentiometers, whereby these may be used as external potentiometers for the

Control Signal Selector Type 4410. Pin 1: Top. Pin 2: Tapping point. Pin 4: Ground.

DC-Output.

7-pin socket (Cannon WK-A7-32S) for the two DC outputs to the Control Signal Selector Type 4410. Pin 1: Unsmoothed signal. Pin 3: Smoothed signal. Pins 5 and 7: Ground.



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Fig. 3.4. Rear panel of the Vibration Meter.

External Filter.

7-pin socket (Cannon WK-A7-32S) for the connection of an external filter when special frequency characteristics are wanted. Pin 1: Filter input. Pin 2: Filter output. Pin 4: Ground. Pin 5: - 6 V DC for filter amplifier etc.

Acc. Density Input.

3-pin socket (Cannon WK-C3-32S) for an acceleration density input from a heterodyne analyzer scaled to give 1 volt per g^2/Hz . Pin 2: Signal. Pins 1 and 3: Ground.

Relay Control.

7-pin socket (Cannon WK-A7-32S) for relay control of low frequency cut-off, meter time constant and cross-over from the signal generator.

Cross-Over.

7-pin socket (Cannon WK-A7-32S) which may be used for obtaining different cross-over combinations by suitable connection to the REMOTE FUNCTION SELECTOR socket. Pin 5: - 6 V DC below cross-over. Pin 6: - 6 V DC above cross-over. Pin 4: Ground. Pin 3: - 6 V DC.

Remote Function Selector.

7-pin socket (Cannon WK-A7-32S) for remote operation of the FUNCTION

SELECTOR when set to "Auto". The socket is connected to the REMOTE FUNCTION SELECTOR socket of the Vibration Programmer or to the CROSS-OVER socket described above. A -6 V DC voltage is required for operation of the relays. Pin 1: Acceleration Gradient. Pin 2: Acceleration. Pin 3: Velocity. Pin 4: Ground. Pin 5: External Filter. Pin 6: Displacement. Pin 7: Range $\times 10$.

Acceleration Input.

3-pin socket (Cannon WK-C3-32S) for the acceleration signal from a pre-amplifier scaled to 10 mV/g. Pin 2: Signal. Pins 1 and 3: Ground.

4. Description of Control Signal Selector Type 4410

4.1. General Description.

A block diagram of the Control Signal Selector is shown in Fig. 4.1. It is a four channel selector which can be used for automatically selecting the largest or smallest signal from up to four Vibration Meters Type 2502. The Selector can also be set to average the signals or any one of the signals can be chosen manually. The average is obtained from the unfiltered DC voltages from the rectifiers in the Vibration Meters. Different test philosophies have thus been catered for. (See for example "Control of Sinusoidal Vibration Tests Using Averaging Systems" by S. M. Ostergren, Proc. Inst. Environmental, Sciences pp. 215, 1966).

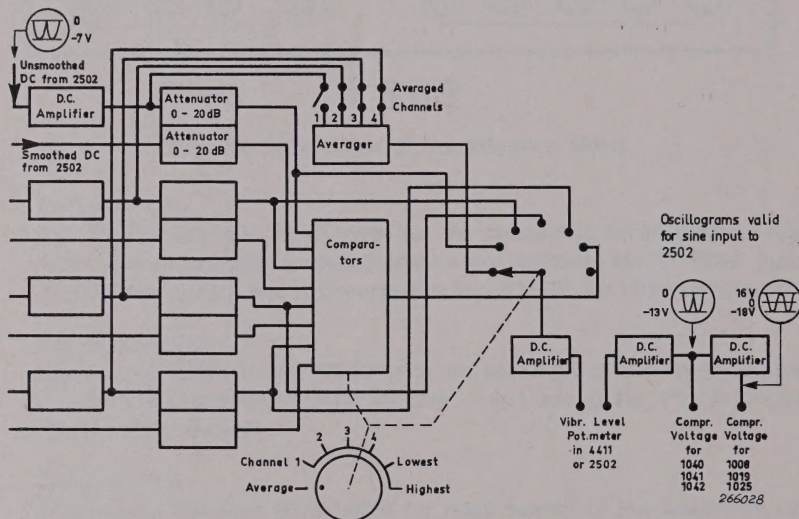
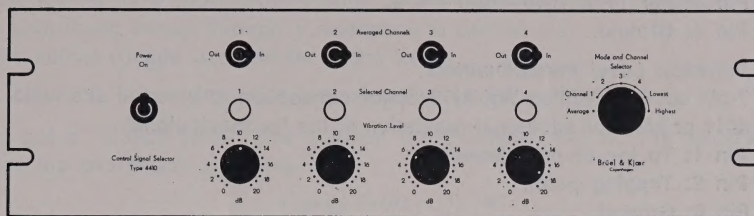


Fig. 4.1. Block diagram of the Control Signal Selector.

In all four channels there is a 0-20 dB attenuator, so that each signal can be attenuated up to 20 dB before selection. Further attenuation of the selected signal is accomplished by connection to the Vibration Level Potentiometers in the Vibration Meter or Vibration Programmer.

DC amplifiers are included in the Control Signal Selector to compensate for the loss of amplification when the compressor amplifier in the control generator is bypassed. The generators Type 1019, 1008, 1025 employ one more amplifier than Type 1040, 1041, 1042.



4410

Fig. 4.2. Front panel of the Control Signal Selector.

4.2. Front Panel.

The front panel of the Control Signal Selector is shown in Fig. 4.2. The switches and knobs are as follows:

Mode and Channel Selector.

7-position switch for choosing the type of feedback control for the generator.

- 1: Average of up to four channels.
- 2: Channel 1.
- 3: Channel 2.
- 4: Channel 3.
- 5: Channel 4.
- 6: Lowest of up to four channels.
- 7: Highest of up to four channels.

Averaged Channels.

In-Out switches for the channels to be averaged.

Selected Channel.

Lamps indicating which channel is used for control at any time. (Not in "Average").

Vibration Level.

0–20 dB attenuators for attenuation of the channel signals before selection.
2 dB steps.

4.3. Rear Panel.

The rear panel of the Control Signal Selector is shown in Fig. 4.3. The sockets are as follows:

Compressor Voltage.

7-pin socket (Cannon WK-A7-32S) for the DC compressor voltage for the compressor circuit of the signal generator.

Pin 1: For Type 1019 – 1008 – 1025.

Pin 3: For Type 1040 – 1041 – 1042.

Pin 4: Ground.

Vibration Level Potentiometers.

7-pin socket (Cannon WK-A7-32S) for connection to external attenuator in 4411 or 2502 for additional regulation of the feedback signal.

Pin 1: To top of potentiometer.

Pin 2: Tapping point.

Pin 6: Ground.

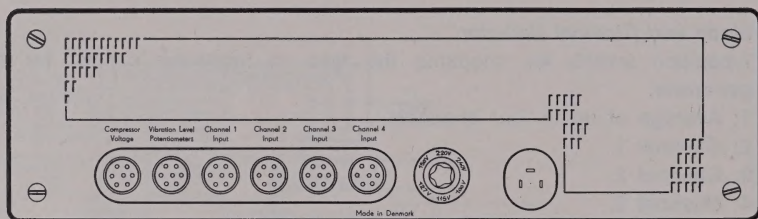
Channel Inputs.

7-pin socket (Cannon WK-A7-32S) for DC voltages from the Vibration Meters.

Pin 1: Unsmoothed signal.

Pin 3: Smoothed signal.

Pin 5: Ground.



4410

Fig. 4.3. Rear panel of the Control Signal Selector.

4.4. Calculation of the Switching Time of the Control Signal Selector.

As the selecting circuit of 4410 selects on the filtered DC voltages from the meter circuit of the Vibration Meter Type 2502, there will, for a voltage change on the input of 2502, be introduced a time delay in the change of voltage on the filtered DC output and hence a "switching time" in 4410.

This delay depends essentially on two factors: the rate of change of voltage and the meter time constant of 2502. For the calculation of this time delay, Δt , an input voltage with constant logarithmic change is used:

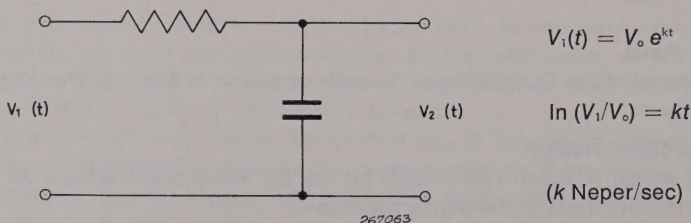


Fig. 4.4. Equivalent circuit for calculation of the switching time in 4410.

This should be a good approximation to the voltage change introduced when a *logarithmic* sweep through a resonance is carried out.

The output voltage $V_2(t)$ will be of the form:

$$V_2(t) = V_0 [e^{kt} - k\tau (k\tau + 1)^{-1} (e^{kt} - e^{-t/\tau})]$$

To get a "steady state" time solution the transient term $e^{-t/\tau}$ is dropped so that the expression becomes

$$V_2(t) \cong V_0 (k\tau + 1)^{-1} e^{kt}$$

The time delay between $V_1(t)$ and $V_2(t)$ will thereby be:

$$\Delta t = k^{-1} \ln (k\tau + 1)$$

As the meter circuit of the 2502 is an RMS circuit the charging time constant τ is less than the discharging time constant τ_M given on the front panel of 2502.

The connection between τ_M and τ has been measured, and the results are:

τ_M	τ
30 sec.	10.9 sec.
10 sec.	3.5 sec.
3 sec.	1.03 sec.
1 sec.	0.39 sec.
0.3 sec.	0.1 sec.

It should be remembered that there is a 20 % tolerance on τ_M and therefore also on τ .

In the preceding text k has been expressed in terms of Neper/sec but this is normally not used in practical measurements. A new K is therefore introduced, defined as:

$$K = 8.69 \times k \quad \text{dB/sec.}$$

K is found from the expression

$$K = \frac{A \times B}{60 \times C} \quad \text{dB/sec, where}$$

A (deg./min) is the scanning speed.

B (dB/oct.) is the flank steepness of the resonance considered.

C (deg./oct.) is the scale resolution = 22 for the generators 1008, 1019, 1025, 1040, 1041 and 1042.

When selecting the "Highest" signal with 4410 it is naturally the charging time constant τ which is of interest and therefore a curve

$$\Delta t = f(K, \tau)$$

is given for this in Fig. 4.6.

The possible overttest D is also given on the chart as this curve is given by

$$D = K \times \Delta t \quad \text{dB}$$

To the value found for D the tolerance of the selectors in 4410 $\approx \pm 0.1$ dB must be added.

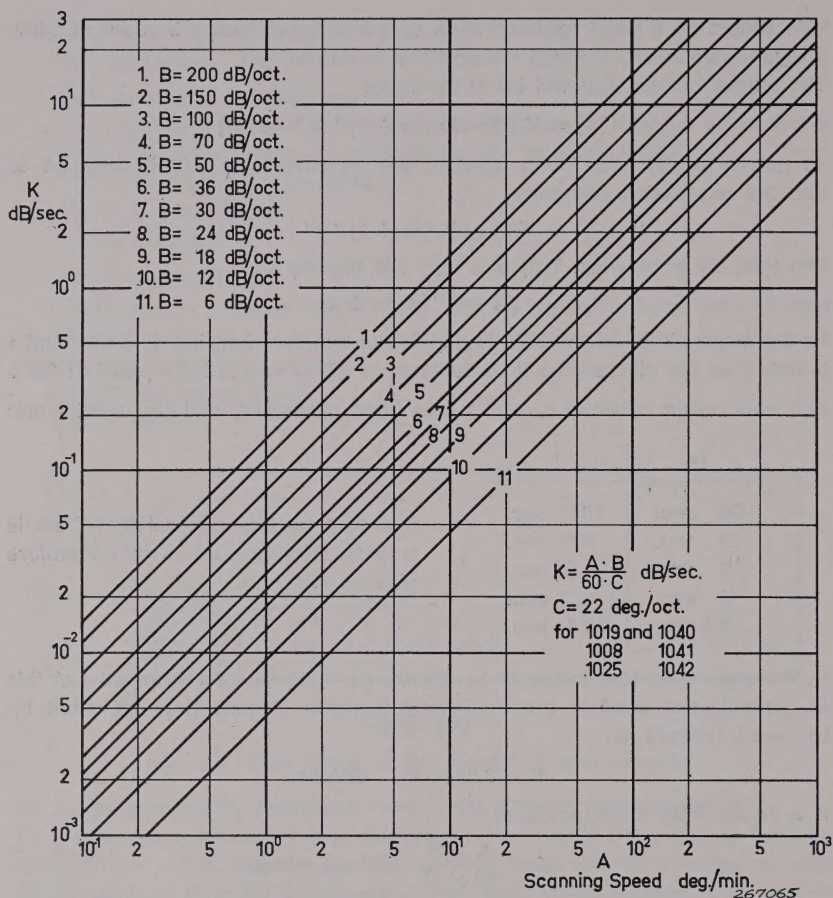


Fig. 4.5. K as a function of the scanning speed A for different values of the flank steepness B .

For the sake of convenience a curve of the function

$$K = f(A, B), C = 22 \text{ deg./oct.}$$

is given on a separate chart, Fig. 4.5.

Example 1:

When sweeping through a resonance, the flank steepness of which is *measured* to be 100 dB/oct., with a scanning speed of 10 deg./min. the K value is found from Fig. 4.5.

$$K = 0.76 \text{ dB/sec.}$$

By using this K and, say, $\tau_M = 1$ sec., Δt and D can be found from Fig. 4.6.

$$\Delta t = 0.39 \text{ sec.}$$

$$D = 0.3 \pm 0.1 \text{ dB}$$

Example II:

Flank steepness = 100 dB/oct.

Scanning speed = 330 deg./min.

$$\tau_M = 0.3 \text{ sec.}$$

$$K = 25 \text{ dB/sec.}$$

$$\Delta t = 0.085 \text{ sec.}$$

$$D = 2.2 \pm 0.1 \text{ dB}$$

To be able to keep D as low as calculated in this way it is necessary to use a relatively high compressor speed. This speed being determined by trial and error. As described in section 3.4, the 2502 includes the facility of automatic switching of the meter time constant as a function of frequency. This will reduce Δt at higher frequencies.

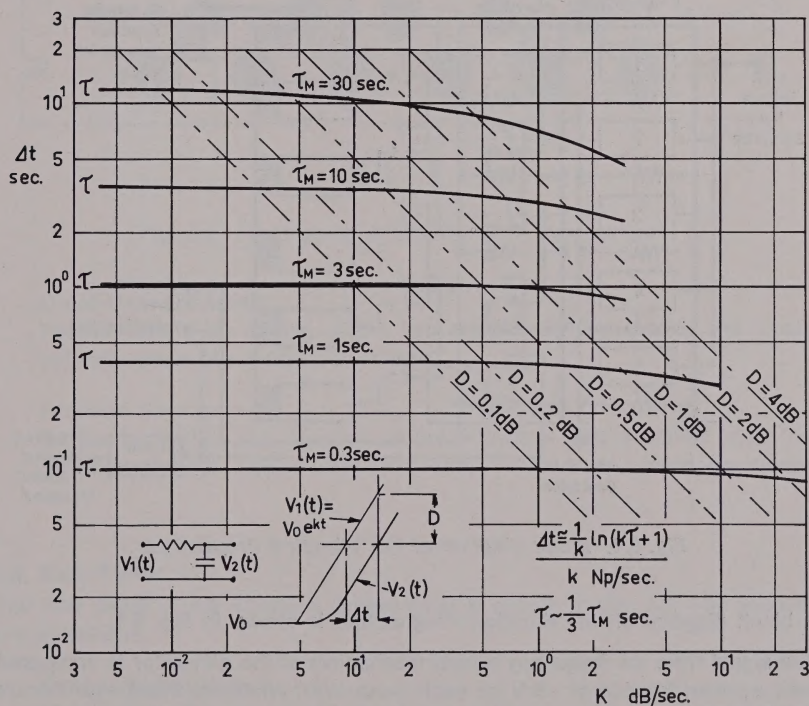


Fig. 4.6. The charging time Δt as a function of K for different values of τ_M .

5. Description of Vibration Programmer Type 4411

5.1. General Description.

The Vibration Programmer is used for automatic control of up to four Vibration Meters Type 2502 as a function of frequency. Frequency information is obtained as a DC voltage from a potentiometer on the sweep mechanism of the vibration control generator. Five multiturn potentiometers are used for adjusting five cross-over frequencies, so that within one frequency sweep six different functions of the Vibration Meter can be utilized.

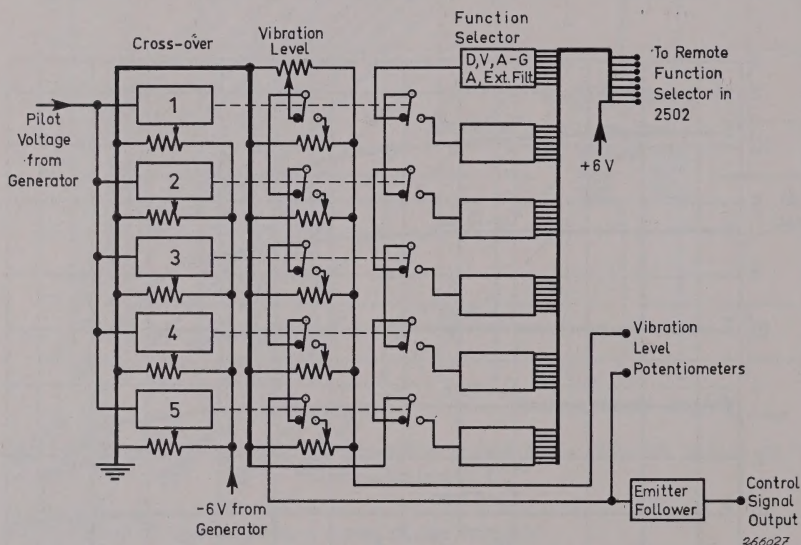


Fig. 5.1. Block diagram of the Vibration Programmer.

A block diagram of the Vibration Programmer is shown in Fig. 5.1.

The signal from the frequency sweep mechanism of the generator is compared with a preset fraction of -6 V for each cross-over. When the cross-over occurs a new potentiometer and a new function selector are switched in, so that level and function are individually set on either side of each cross-over frequency.

The function selector directs a 6 V supply from the Vibration Meter back to the appropriate relay for a function control.

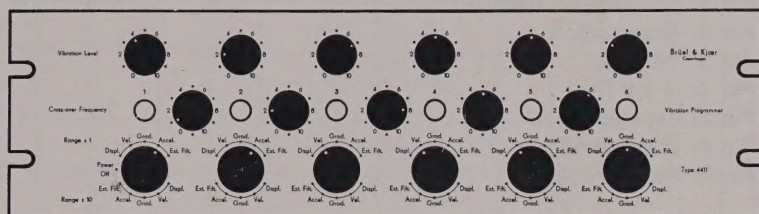
An emitter follower is included for operation with AC signals (Without the Control Signal Selector).

5.2. Front Panel.

The front panel of the Vibration Programmer is shown in Fig. 5.2. The control knobs etc. are as follows:

Vibration Level.

Potentiometers for individual control of the vibration in the six frequency ranges.



4411

Fig. 5.2. Front panel of the Vibration Programmer.

Cross-Over Frequency.

Potentiometers for setting of the five cross-over frequencies. The lamps indicate where the cross-over occurs.

Function Selector.

Switch for setting the function of the Vibration Meters within each frequency subrange. Upper positions: Range $\times 1$. Lower positions: Range $\times 10$.

5.3. Rear Panel.

The rear panel of the Vibration Programmer is shown in Fig. 5.3. The sockets are as follows:

Control Signal Output.

7-pin socket (Cannon WK-A7-32S) for the control signal to the compressor input of the vibration control generator, for example in the combination

2502 – 4411 – 1042.

Pin 1: Signal. Pin 4: Ground.

Vibration Level Potentiometers.

7-pin socket (Cannon WK-A7-32S) for interconnection of the vibration level controls in 4411 with those in 2502 or 4410: Pin 1: Top of potentiometers. Pin 5: Midpoint. Pin 4: Ground.

Pilot Voltage.

7-pin socket (Cannon WK-A7-32S) for the pilot voltage from the generator. Pin 2: Pilot voltage. Pin 3: – 6 V DC from generator. Pin 4: Ground.

Remote Function Selector.

7-pin socket (Cannon WK-A7-32S) for connection to the remote function selector of the Vibration Meter.

Pin 1: Acceleration Gradient.

Pin 2: Acceleration.

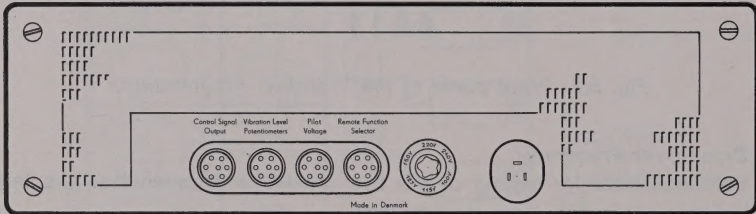
Pin 3: Velocity.

Pin 4: + 6 V DC.

Pin 5: External Filter.

Pin 6: Displacement.

Pin 7: Range $\times 10$.



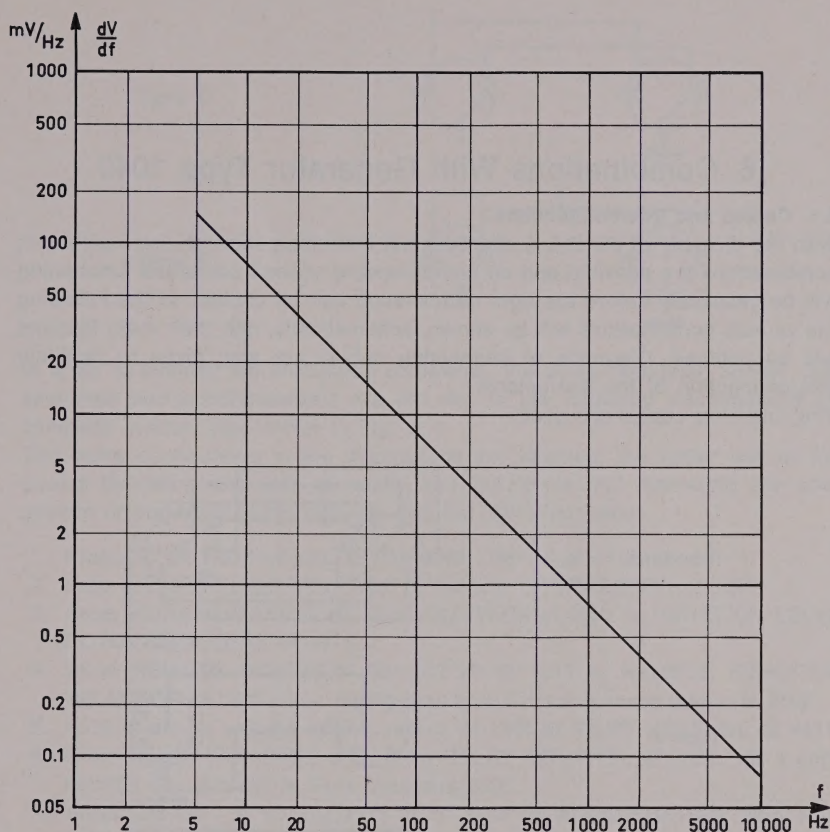
4411

Fig. 5.3. Rear panel of the Vibration Programmer.

5.4. Resolution of the Pilot Voltage.

As the pilot voltage potentiometer is linear and the frequency sweep is truly logarithmic with Frequency Range of the generator in its basic position, the deviation of the Pilot Voltage is constant for a constant percentage deviation of the frequency.

A small change of voltage may occur during the warm up time but this does not affect the resolution and it has no influence on the functioning of the Vibration Programmer Type 4411. In Fig. 5.4 the resolution in mV/Hz is given as a function of frequency.



26706B

Fig. 5.4. Resolution of Pilot Voltage from the vibration control generator in the truly logarithmic frequency range:

5– 5000 Hz for generators 1019 – 1008 – 1025
 10–10000 Hz for generators 1040 – 1041 – 1042

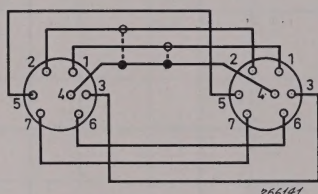
6. Combinations With Generator Type 1040

6.1. Cables and Interconnections.

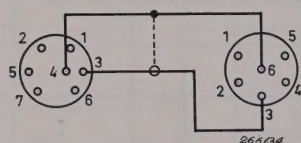
With the diversity of the B & K vibration test instrumentation several instrument combinations are possible and an understanding of their combined functioning will be necessary before the right combination can be chosen. In the following the various combinations will be shown, schematically, and their main features will be outlined. Diagrams of connecting cables are also given to facilitate interconnection of the instruments.

The following cables are used:

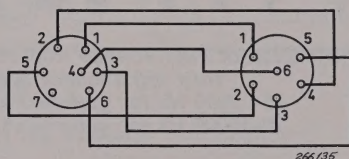
Standard



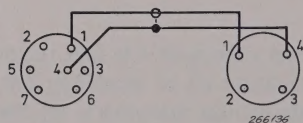
Type A



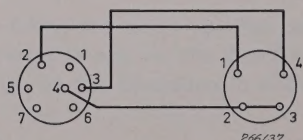
Type B



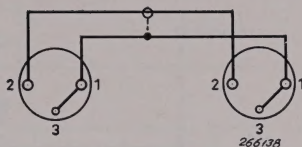
Type C



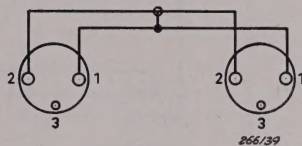
Type D



Type E



Type F



In order to simplify the illustration somewhat, the power amplifier, shaker, test specimen and accelerometers are left out in the following combinations (A complete system was shown in Fig. 2.1).

The cable connections in the illustrations are labelled, the upper half of the circles indicating the type of cable, and the lower half indicating the connection of the cable in accordance with the following table:

1. From DC OUTPUT of 2502 to CHANNEL INPUT of 4410.
2. From COMPRESSOR VOLTAGE of 4410 to COMPRESSOR of 1040.
3. From VIBRATION LEVEL POTENTIOMETERS of 4410 to VIBRATION LEVEL POTENTIOMETERS of 4411.
4. From REMOTE FUNCTION SELECTOR of 4411 to REMOTE FUNCTION SELECTOR of 2502, via a connection box if there is more than one 2502.
5. From the pilot voltage output socket of 1040 to PILOT VOLTAGE of 4411.
6. From RELAY CONTROL of 1040 to RELAY CONTROL of 2502, via a connection box if there is more than one 2502.
7. From OUTPUT A or OUTPUT B of 2622 to ACCELERATION INPUT of 2502. In order to avoid ground loops the accelerometers should be isolated from ground and each Preamplifier Type 2622 should only be grounded at one point. One E cable and one F cable are therefore used for each preamplifier as shown in the figures.
8. From VIBRATION LEVEL POTENTIOMETERS of 4410 to VIBRATION LEVEL POTENTIOMETERS of 2502. The connection between pins 1 and 3 in 2502 to be removed and connection between 1 and 7 to be changed to 3 and 7.
9. From CONTROL SIGNAL OUTPUT of 4411 to COMPRESSOR INPUT of 1040.
10. From VIBRATION LEVEL POTENTIOMETERS of 2502 to VIBRATION LEVEL POTENTIOMETERS of 4411.
11. From CONTROL SIGNAL OUTPUT of 2502 to COMPRESSOR INPUT of 1040.

Standard Cables (AO 0058) 2 m long and Connection Boxes (JJ 0036) for parallel connection of 5 Standard Cables are available on request.

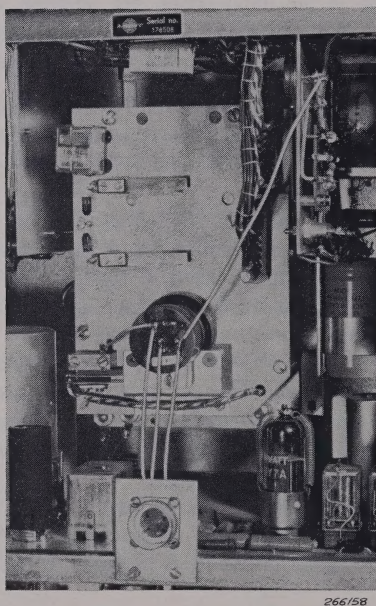
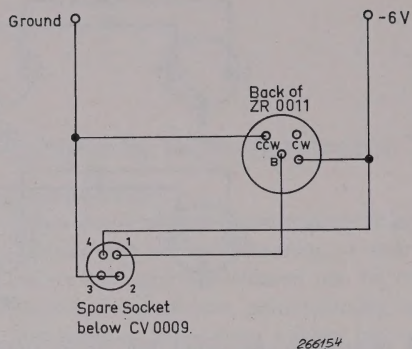
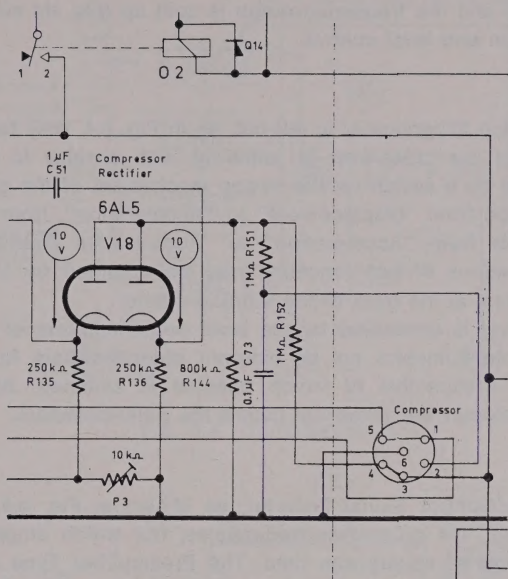


Fig. 6.1. Connection of the Potentiometer ZR 0011 for the pilot voltage.

6.2. Pilot Voltage.

The frequency dependent DC voltage for control of the Vibration Programmer is obtained by fixing a potentiometer ZR 0011 to the sweep mechanism at the back of the signal generator. This potentiometer is connected to the socket just below the sweep mechanism as shown in Fig. 6.1.



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Fig. 6.2. Modification of the COMPRESSOR socket of 1040 for operation with 2502, 4410 and 4411.

6.3. Modification to Generator.

Before the Sine-Random Generator Type 1040 is connected in a system with 2502, 4410 and 4411 its COMPRESSOR socket at the back should be connected as shown in Fig. 6.2. When this socket is connected to COMPRESSOR VOLTAGE in 4410, the connection between pins 3 and 4 of the COMPRESSOR socket must be removed, i.e. in the two first combinations below. In the two last combinations the link is left in.

6.4. Modification to Vibration Meter.

For Combination II the short-circuiting link between pins 1 and 3 in the VIBRATION LEVEL POTENTIOMETERS socket of the Vibration Meter whose potentiometers are used as external potentiometers for the Control Signal Selector should be removed, and the connection between pins 1 and 7 should be changed to 3 and 7.

6.5. Combinations.

I.

Fig. 6.3 shows a system which utilizes the whole instrument range. There are four control accelerometers (B & K Type 4332-35 or 4340) two 2-channel pre-amplifiers and four Vibration Meters. Thus the vibration is controlled at up

to four positions and the frequency range is split up into six sub-ranges with individual function and level control.

II.

When the Vibration Programmer is left out, as in Fig. 6.4, only two sub-ranges are retained and the cross-over is achieved with a relay in the Vibration Meter, controlled by a switch on the sweep mechanism of the generator. The cross-over may be from "Displacement" to "Acceleration", from "Velocity" to "Acceleration" or from "Acceleration" to "Acceleration Gradient". The remaining combinations of two functions may be obtained by short-circuiting appropriate sockets at the back of the Vibration Meter.

The vibration level is controlled by the level potentiometers of the Vibration Meter whose potentiometers act as external potentiometers for the Control Signal Selector irrespective of which channel is selected, as the control signals to the Selector are taken out before the potentiometers.

III.

Leaving out the Control Signal Selector, as shown in Fig. 6.5, results in a system which has five cross-over frequencies, but which employs only one control accelerometer at any one time. The Preamplifier Type 2622 has two channels, so that two accelerometers may be used, and a switch-over from one to the other can be done automatically at some pre-selected frequency, for example by using the generator switching at 30 - 100 - 300 Hz or the "cross-over" switch.

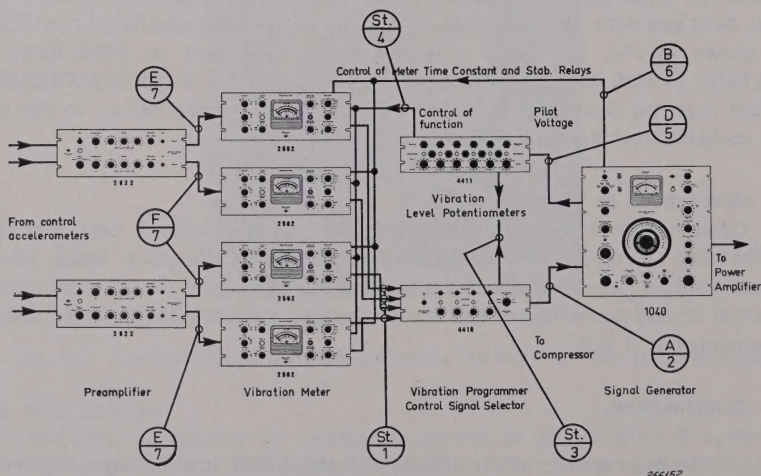


Fig. 6.3. Combination I.

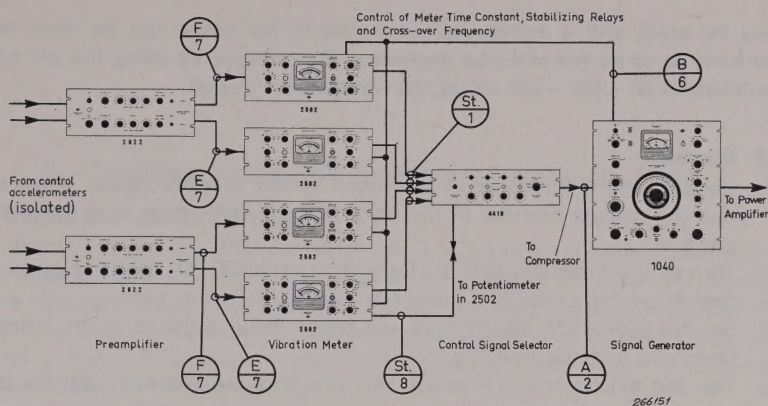


Fig. 6.4. Combination II.

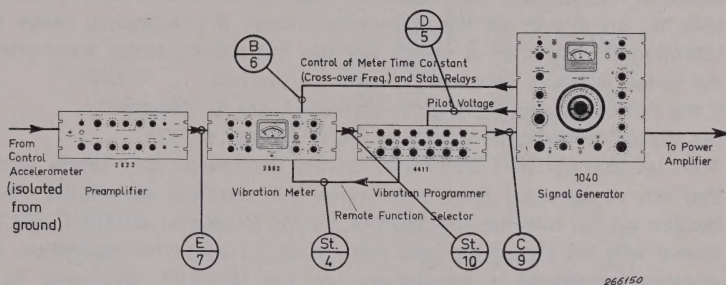


Fig. 6.5. Combination III.

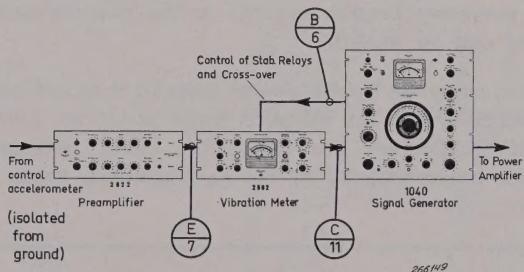


Fig. 6.6. Combination IV.

IV.

The set-up in Fig. 6.6 has one cross-over frequency with function combinations as that of Fig. 6.4. Only one control accelerometer is used at any one time. The Preamplifier Type 2622 has two channels, so that two accelerometers

may be used, and a switch-over from one to the other can be done automatically at some pre-selected frequency, for example by using the generator switching at 30 – 100 – 300 Hz, or the "cross-over" switch.

6.6. Operation.

1. Connect the instruments as indicated by the relevant figure. Make sure that the voltage selector at the back of each instrument is in the correct position.
2. Turn all level controls and the Generator OUTPUT VOLTAGE to zero.
3. Switch on the power and allow five minutes warm-up time.
4. Set the FUNCTION SELECTOR and meter range switches of the Vibration Meters to suitable positions.
5. Tap the accelerometers gently and see that the vibration signals show up on the Vibration Meters.
6. Calibrate the frequency scale of the generator as described in its instruction manual. Set the cross-over frequencies to the required positions. (Set the cross-over on the Generator outside the frequency range if the Vibration Programmer is used). Set the frequency pointer somewhere in the range which is going to be used for the test.
7. If the Control Signal Selector is employed, set to "Highest".
8. Set the COMPRESSOR switch of the Generator to "On".
9. Turn up the OUTPUT VOLTAGE of the Generator very slowly and see that the compressor loop suppresses the vibration amplitude. The deflection on the relevant Vibration Meter for Generator OUTPUT VOLTAGE turned fully on should be less than about 0.1 times full deflection. If the vibration amplitude is excessive, turn the OUTPUT VOLTAGE to zero again and locate the cause.
10. If the compressor loop is working properly, set the Control Signal Selector and the remaining control switches to the required positions whereby the testing may be started.

In combinations using the Control Signal Selector it should be noted that the FUNCTION SELECTOR of the Vibration Meter is set to "Auto" whereby the FUNCTION SELECTOR and the VIBRATION LEVEL potentiometers of the Vibration Meter are substituted by the corresponding knobs of the Control Signal Selector.

WARNING

When the red DANGER lamp is alight, the knobs with red spots must not be touched by unauthorized personnel, otherwise permanent damage may be caused to the specimen and shaker table.

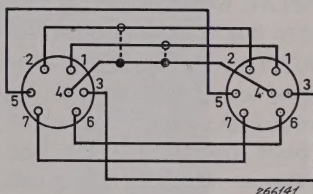
7. Combinations With Generator Type 1041

7.1. Cables and Interconnections.

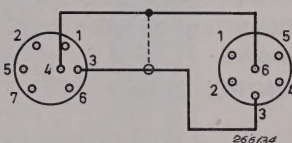
With the diversity of the B & K vibration test instrumentation several instrument combinations are possible and an understanding of their combined functioning will be necessary before the right combination can be chosen. In the following the various combinations will be shown, schematically, and their main features will be outlined. Diagrams of connecting cables are also given to facilitate interconnection of the instruments.

The following cables are used:

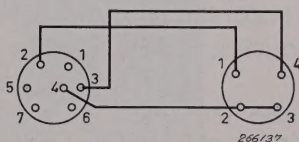
Standard



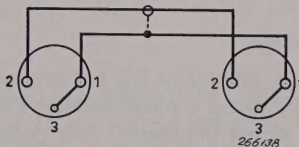
Type A



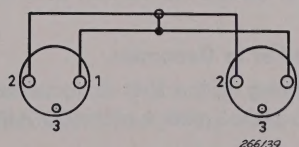
Type D



Type E



Type F



In order to simplify the illustrations somewhat, the power amplifier, shaker, test specimen and accelerometers are left out in the following combinations (a complete system was shown in Fig. 2.1).

The cable connections in the illustrations are labelled, the upper half of the circles indicating the type of cable, and the lower half indicating the connection of the cable in accordance with the following table:

1. From DC OUTPUT of 2502 to CHANNEL INPUT of 4410.
2. From COMPRESSOR VOLTAGE of 4410 to COMPRESSOR of 1041.
3. From VIBRATION LEVEL POTENTIOMETERS of 4410 to VIBRATION LEVEL POTENTIOMETERS of 4411.
4. From REMOTE FUNCTION SELECTOR of 4411 to REMOTE FUNCTION SELECTOR of 2502, via a connection box if there is more than one 2502.
5. From the pilot voltage output socket of 1041 to PILOT VOLTAGE of 4411.
6. From RELAY CONTROL of 1041 to RELAY CONTROL of 2502, via a connection box if there is more than one 2502.
7. From OUTPUT A or OUTPUT B of 2622 to ACCELERATION INPUT of 2502. In order to avoid ground loops the accelerometers should be isolated from ground and each Preamplifier Type 2622 should only be grounded at one point. One E cable and one F cable are therefore used for each preamplifier as shown in the figures.
8. From VIBRATION LEVEL POTENTIOMETERS of 4410 to VIBRATION LEVEL POTENTIOMETERS of 2502. The connection between pins 1 and 7 in 2502 to be removed.
9. From CONTROL SIGNAL OUTPUT of 4411 to COMPRESSOR INPUT of 1041.
10. From VIBRATION LEVEL POTENTIOMETERS of 2502 to VIBRATION LEVEL POTENTIOMETERS of 4411.
11. From CONTROL SIGNAL OUTPUT of 2502 to COMPRESSOR INPUT of 1041.

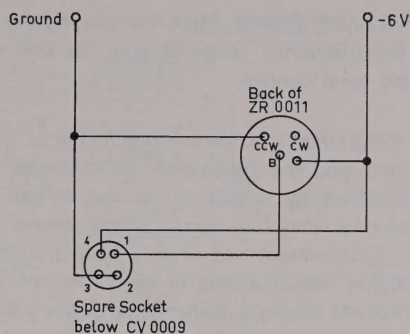
Standard Cables (AO 0058) 2 m long and Connection Boxes (JJ 0036) for parallel connection of 5 Standard Cables are available on request.

7.2. Pilot Voltage.

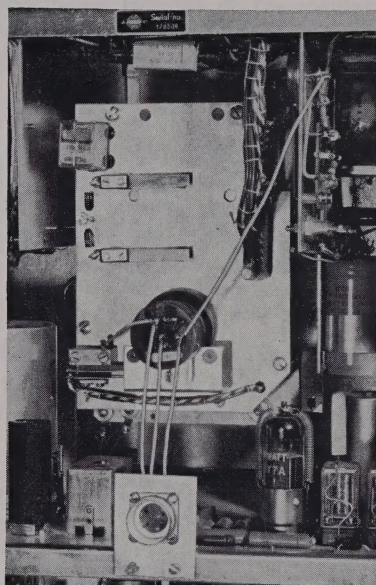
The frequency dependent DC voltage for control of the Vibration Programmer is obtained by fixing a potentiometer ZR 0011 to the sweep mechanism at the back of the signal generator. This potentiometer is connected to the socket just below the sweep mechanism as shown in Fig. 7.1.

7.3. Modification to Generator.

When connecting up the 1041 in combination I and II below, the short-circuiting link between pins 3 and 4 of the COMPRESSOR socket should be removed.



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266158

Fig. 7.1. Connection of the Potentiometer ZR 0011 for the pilot voltage.

7.4. Modification to Vibration Meter.

The short-circuit between pins 1 and 3 of the VIBRATION LEVEL POTENTIOMETER socket of the Vibration Meter which is used for presetting the vibration level should be removed for all combinations with Generator Type 1041.

7.5. Combinations.

I.
Fig. 7.2 shows a system which utilizes the whole instrument range. There are four control accelerometers (B & K Type 4332-35 or 4340), two 2-channel pre-

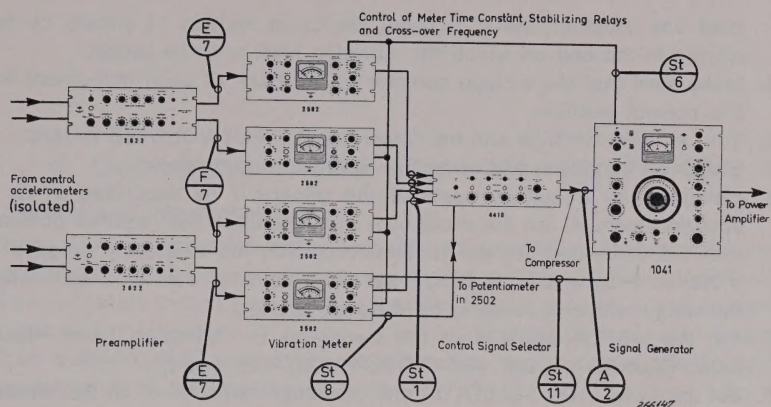


Fig. 7.3. Combination II.

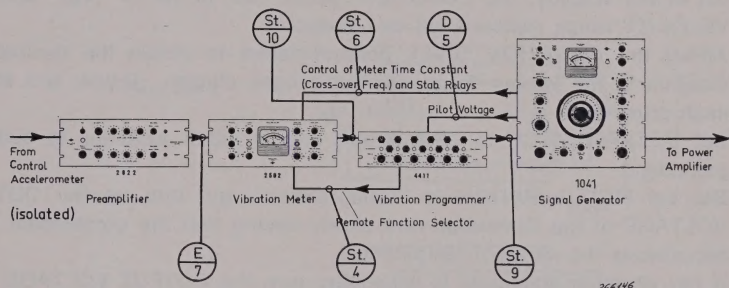


Fig. 7.4. Combination III.

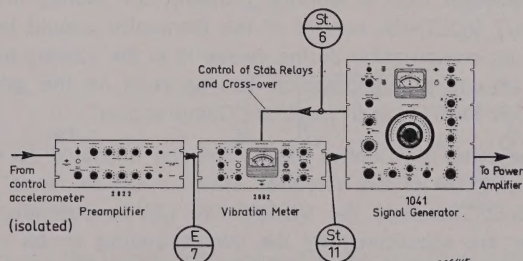


Fig. 7.5. Combination IV.

may be used, and a switch-over from one to the other can be done automatically at some pre-selected frequency, for example by using the generator switching at 30 – 100 – 300 Hz or the "cross-over" switch.

7.6. Operation.

1. Connect the instruments as indicated by the relevant figure. When more

than one Vibration Meter is used, the cable marked 11 should be connected to the one on which the vibration level is to be preset.

2. Make sure that the voltage selector at the back of each instrument is in the correct position.
3. Turn all level controls and the Generator OUTPUT VOLTAGE to zero.
4. Switch on the power and allow five minutes warm-up time.
5. Calibrate the frequency scale of the generator as described in its instruction manual. Set the cross-over frequencies to the required positions. (Set the cross-over on the Generator outside the frequency range if the Vibration Programmer is used). Set the frequency pointer somewhere in the range which is going to be used for the test.
6. Set the METER SWITCH of the Generator to "Vibration Level Preset", COMPRESSOR to "On" and OUTPUT VOLTAGE fully on.
7. Set the FUNCTION SELECTOR and the range switches of all the Vibration Meters to suitable positions, for example to preset a vibration level of 0.3 in/sec velocity, the FUNCTION SELECTOR is set to "Vel" and the VELOCITY range switch is set to 1 in/sec.
8. Adjust the VIBRATION LEVEL potentiometers to obtain the desired indication in the various frequency sub-ranges chosen. (Below and above each cross-over).
9. Set METER SWITCH to "Stand by", and all other switches to suitable positions.
10. Set the METER SWITCH to "Compression" and turn up the OUTPUT VOLTAGE of the Generator very slowly seeing that the compressor loop suppresses the vibration amplitude.
If the vibration amplitude is excessive, turn the OUTPUT VOLTAGE fully counter-clockwise again and locate the cause.
11. If the compressor loop is working properly, the testing may be started. The OUTPUT VOLTAGE control of the Generator should be adjusted so that minimum compression during sweep is in the vicinity of 0 dB but not less. The amount of compression can be read on the generator meter when METER SWITCH is in position "Compression".

In combinations using the Control Signal Selector it should be noted that the FUNCTION SELECTOR of the Vibration Meter is set to "Auto" whereby the FUNCTION SELECTOR and the VIBRATION LEVEL potentiometers of the Vibration Meter are substituted by the corresponding knobs of the Control Signal Selector.

WARNING

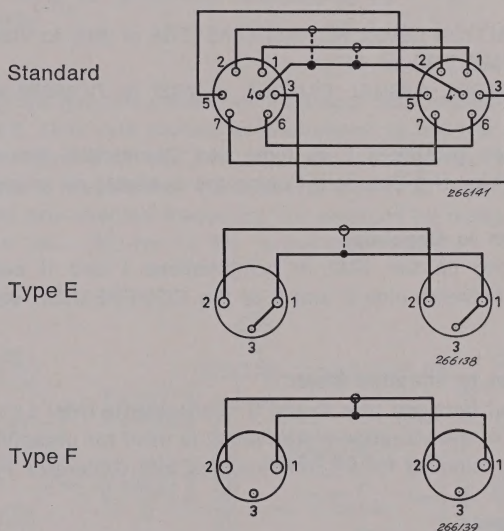
When the red DANGER lamp is alight, the knobs with red spots must not be touched by unauthorized personnel, otherwise permanent damage may be caused to the specimen and shaker table.

8. Combinations With Generator Type 1042

8.1. Cables and Interconnections.

With the diversity of the B & K vibration test instrumentation several instrument combinations are possible and an understanding of their combined functioning will be necessary before the right combination can be chosen. In the following the various combinations will be shown, schematically, and their main features will be outlined. Diagrams of connecting cables are also given to facilitate interconnection of the instruments.

The following cables are used:



In order to simplify the illustrations somewhat, the power amplifier, shaker, test specimen and accelerometers are left out in the following combinations. (A complete system was shown in Fig. 2.1).

The cable connections in the illustrations are labelled, the upper half of the circles indicating the type of cable, and the lower half indicating the connection of the cable in accordance with the following table:

1. From DC OUTPUT of 2502 to CHANNEL INPUT of 4410.
2. From COMPRESSOR VOLTAGE of 4410 to COMPRESSOR of 1042.

3. From VIBRATION LEVEL POTENTIOMETERS of 4410 to VIBRATION LEVEL POTENTIOMETERS of 4411.
4. From REMOTE FUNCTION SELECTOR of 4411 to REMOTE FUNCTION SELECTOR of 2502, via a connection box if there is more than one 2502.
5. From the pilot voltage output socket of 1042 to PILOT VOLTAGE of 4411.
6. From RELAY CONTROL of 1042 to RELAY CONTROL of 2502, via a connection box if there is more than one 2502.
7. From OUTPUT A or OUTPUT B of 2622 to ACCELERATION INPUT of 2502. In order to avoid ground loops the accelerometers should be isolated from ground and each Preamplifier Type 2622 should only be grounded at one point. One E cable and one F cable are therefore used for each preamplifier as shown in the figures.
8. From VIBRATION LEVEL POTENTIOMETERS of 4410 to VIBRATION LEVEL POTENTIOMETERS of 2502. The connection between pins 1 and 7 in 2502 to be removed.
9. From CONTROL SIGNAL OUTPUT of 4411 to COMPRESSOR INPUT of 1042.
10. From VIBRATION LEVEL POTENTIOMETERS of 2502 to VIBRATION LEVEL POTENTIOMETERS of 4411.
11. From CONTROL SIGNAL OUTPUT of 2502 to COMPRESSOR INPUT of 1042.

Standard Cables (AO 0058) 2 m long and Connection Boxes (JJ 0036) for parallel connection of 5 Standard Cables are available on request.

8.2. Modification to Generator.

When connecting up the 1042 in combinations I and II below, the short-circuiting link between pins 3 and 6 of the COMPRESSOR socket should be removed.

8.3. Modification to Vibration Meter.

The short-circuit between pins 1 and 3 of the VIBRATION LEVEL POTENTIOMETER socket of the Vibration Meter which is used for presetting the vibration level should be removed for all combinations with Generator Type 1042.

8.4. Combinations.

I.

Fig 8.1 shows a system which utilizes the whole instrument range. There are four control accelerometers (B & K Type 4332-35 or 4340), two 2-channel pre-amplifiers and four Vibration Meters. Thus the vibration is controlled at up to four positions and the frequency range is split up into six sub-ranges with individual function and level control.

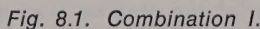
II.

When the Vibration Programmer is left out, as in Fig. 8.2, only two frequency subranges are retained and the cross-over is achieved with a relay in the

The vibration level is controlled by the level potentiometers of the Vibration Meter whose potentiometers act as external potentiometers for the Control Signal Selector irrespective of which channel is selected, as the control signals to the Selector are taken out before the potentiometers.

Leaving out the Control Signal Selector, as shown in Fig. 8.3, results in a system which has five cross-over frequencies, but which employs only one control accelerometer at any time. The Preamplifier Type 2622 has two channels, so that two accelerometers may be used, and a switch-over from one to the other can be done automatically at some pre-selected frequency, for example by using the generator switching at 30 – 100 – 300 Hz or the "cross-over" switch.

The set-up in Fig. 8.4 has one cross-over frequency with function combinations as that of Fig. 8.2. Only one control accelerometer is used at any one time. The Preamplifier Type 2622 has two channels, so that two accelerometers may be used, and a switch-over from one to the other can be done automatically at some pre-selected frequency, for example by using the generator switching at 30 – 100 – 300 Hz, or the "cross-over" switch.



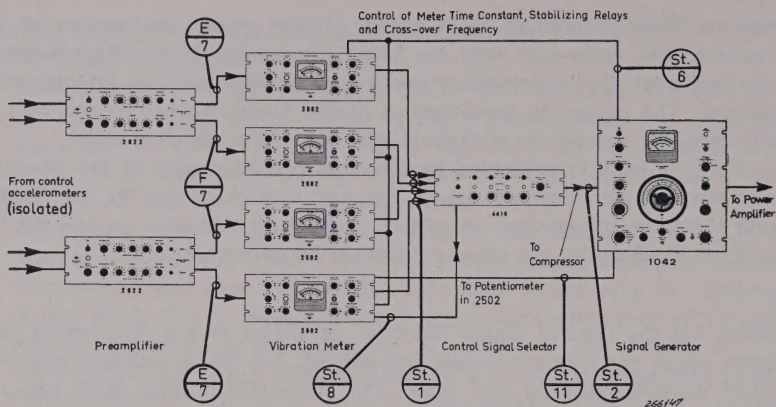


Fig. 8.2. Combination II.

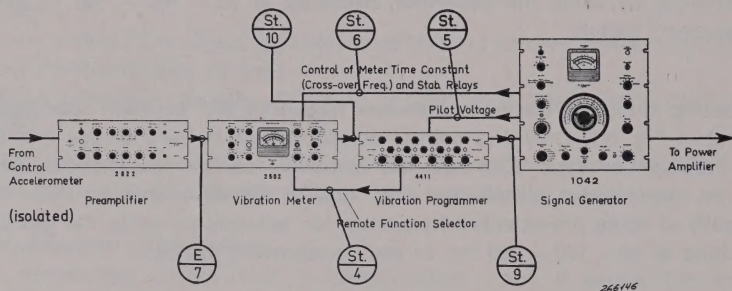


Fig. 8.3. Combination III.

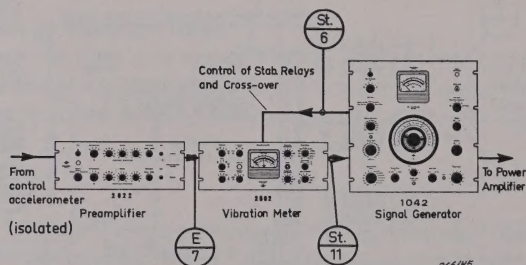


Fig. 8.4. Combination IV.

8.5. Operation.

1. Connect the instruments as indicated by the relevant figure. When more than one Vibration Meter is used, the cable marked 11 should be connected to the one on which the vibration level is to be preset.

2. Make sure that the mains voltage selector at the back of each instrument is in the correct position.
3. Turn all level controls and the Generator OUTPUT VOLTAGE to zero.
4. Switch on the power and allow five minutes warm-up time.
5. Calibrate the frequency scale of the generator as described in its instruction manual. Set the cross-over frequencies to the required positions. (Set the cross-over on the Generator outside the frequency range if the Vibration Programmer is used). Set the frequency pointer somewhere in the range which is going to be used for the test.
6. Set the METER SWITCH of the Generator to "Vibration Level Preset" and COMPRESSOR to "On".
7. Set the FUNCTION SELECTOR and the range switches of all the Vibration Meters to suitable positions, for example to preset a vibration level of 0.3 in/sec velocity, the FUNCTION SELECTOR is set to "Vel" and the VELOCITY range switch is set to 1 in/sec.
8. Adjust the VIBRATION LEVEL potentiometers to obtain the desired indication in the various frequency sub-ranges chosen. (Below and above each cross-over).
9. Set METER SWITCH to "Stand by", and all other switches to suitable positions.
10. Set the METER SWITCH to "Compression" and turn up the OUTPUT VOLTAGE of the Generator very slowly seeing that the compressor loop suppresses the vibration amplitude.
If the vibration amplitude is excessive, turn the OUTPUT VOLTAGE fully counter-clockwise again and locate the cause.
11. If the compressor loop is working properly, the testing may be started. The OUTPUT VOLTAGE control of the Generator should be adjusted so that minimum compression during sweep is in the vicinity of 0 dB but not less. The amount of compression can be read on the generator meter when METER SWITCH is in position "Compression".

In combinations using the Control Signal Selector it should be noted that the FUNCTION SELECTOR of the Vibration Meter is set to "Auto" whereby the FUNCTION SELECTOR and the VIBRATION LEVEL potentiometers of the Vibration Meter are substituted by the corresponding knobs of the Control Signal Selector.

WARNING

When the red DANGER lamp is alight, the knobs with red spots must not be touched by unauthorized personnel, otherwise permanent damage may be caused to the specimen and shaker table.

9. Combinations With Generator Type 1019

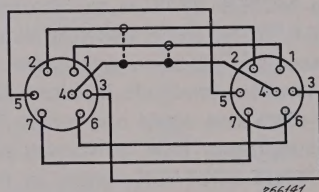
9.1. Cables and Interconnections.

The Automatic Vibration Exciter Control Type 1019 is a combination of a sine generator and a vibration meter, so that basically the Vibration Meter Type 2502 is not necessary for its operation. It may be desirable however, to use the four-accelerometer control and the five cross-over frequencies provided by the Control Signal Selector and the Vibration Programmer. It is then necessary to include 2502 in the system and to bypass the vibration meter section of 1019.

In the following the various combinations are shown schematically, and their main features are outlined. Diagrams of the relevant connecting cables are also given, to facilitate interconnection of the instruments.

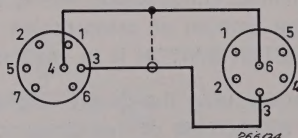
The following cables are used:

Standard



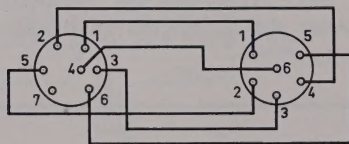
266141

Type A



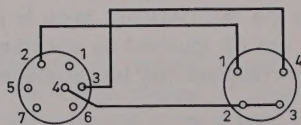
266134

Type B



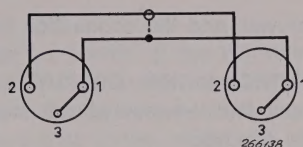
266135

Type D

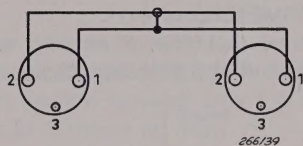


266137

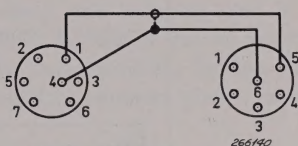
Type E



Type F



Type G



In order to simplify the illustrations somewhat, the power amplifier, shaker, test specimen and accelerometers are left out in the following combinations. (A complete system was shown in Fig. 2.1).

The cable connections in the illustrations are labelled, the upper half of the circles indicating the type of cable, and the lower half indicating the connection of the cable in accordance with the following table:

1. From DC OUTPUT of 2502 to CHANNEL INPUT of 4410.
2. From COMPRESSOR VOLTAGE of 4410 to COMPRESSOR of 1019.
The short-circuiting link between pins 2 and 3 in the COMPRESSOR socket of 1019 to be removed.
3. From VIBRATION LEVEL POTENTIOMETERS of 4410 to VIBRATION LEVEL POTENTIOMETERS of 4411.
4. From REMOTE FUNCTION SELECTOR of 4411 to REMOTE FUNCTION SELECTOR of 2502, via a connection box if there is more than one 2502.
5. From the pilot voltage output socket of 1019 to PILOT VOLTAGE of 4411.
6. From RELAY CONTROL B of 1019 to RELAY CONTROL of 2502, via a connection box if there is more than one 2502.
7. From OUTPUT A or OUTPUT B of 2622 to ACCELERATION INPUT of 2502. In order to avoid ground loops the accelerometers should be isolated from ground and each Preamplifier Type 2622 should only be grounded at one point. One E cable and one F cable are therefore used for each preamplifier as shown in the figures.
8. From VIBRATION LEVEL POTENTIOMETERS of 4410 to VIBRATION LEVEL POTENTIOMETERS of 2502. The connection between pins 1 and 3 in 2502

to be removed, and the connection between pins 1 and 7 to be changed to 3 and 7.

9. From CONTROL SIGNAL OUTPUT of 4411 to COMPRESSOR of 1019. The short circuit link between pins 5 and 1 in the COMPRESSOR socket of 1019 to be removed.
10. From VIBRATION LEVEL POTENTIOMETERS of 2502 to VIBRATION LEVEL POTENTIOMETERS of 4411.

Standard Cables (AO 0058) 2 m long and Connection Boxes (JJ 0036) for parallel connection of 5 Standard Cables are available on request.

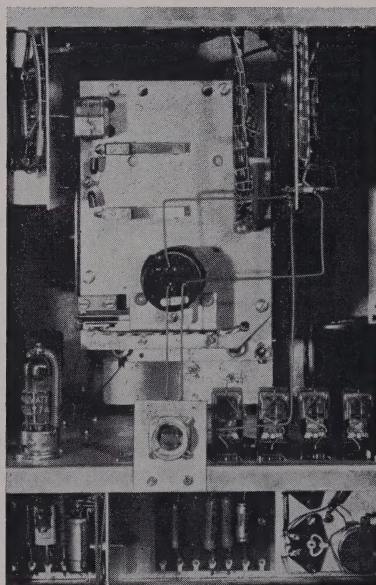
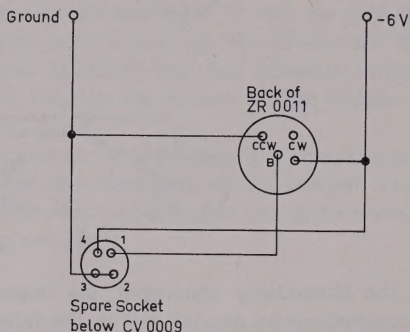


Fig. 9.1. Connection of the potentiometer ZR 0011 for the pilot voltage.

9.2. Pilot Voltage.

The frequency dependent DC voltage for control of the Vibration Programmer is obtained by fixing a potentiometer ZR 0011 to the sweep mechanism at the back of the Vibration Exciter Control. This potentiometer is connected to the socket just below the sweep mechanism as shown in Fig. 9.1.

9.3. Modification to Generator.

When connecting up the 1019 in combinations I and II below, the short-circuiting link between pins 2 and 3 of the COMPRESSOR socket should be removed. For combination III the connection between pins 1 and 5 should be removed while that between pins 2 and 3 should be kept.

9.4. Modification to Vibration Meter.

For Combination II the short-circuiting link between pins 1 and 3 in the VIBRATION LEVEL POTENTIOMETERS socket of the Vibration Meter whose potentiometers are used as external potentiometers for the Control Selector should be removed, and the connection between pins 1 and 7 should be changed to 3 and 7.

9.5. Combinations.

I.

Fig. 9.2. shows a system which utilizes the whole instrument range. There are four control accelerometers, two 2-channel preamplifiers and four Vibration Meters. Thus the vibration is controlled at up to four positions and the frequency range is split up into six subranges with individual function and level control.

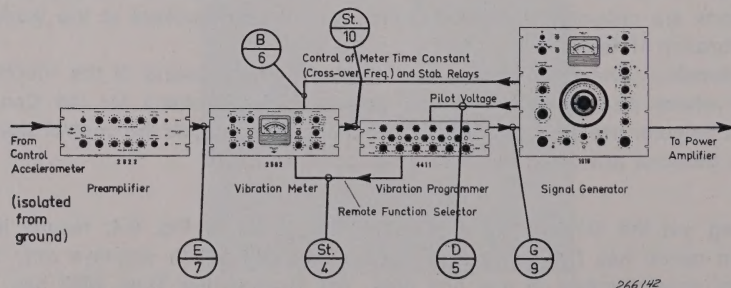
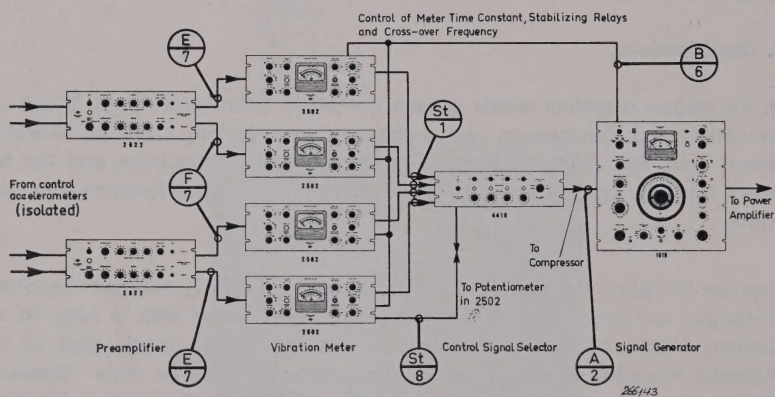
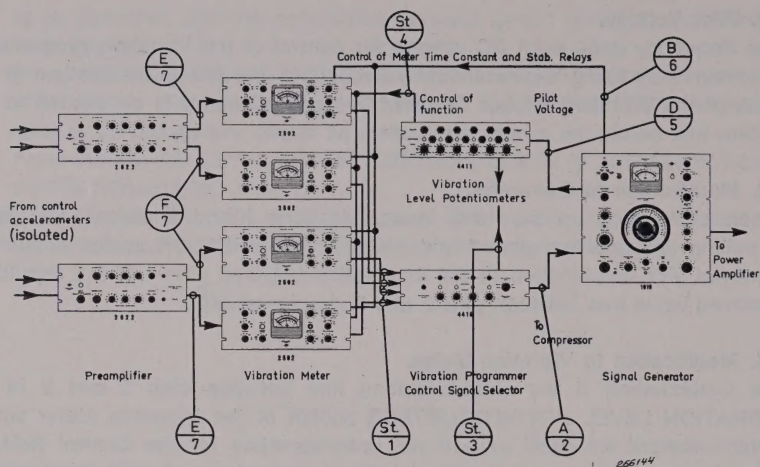
II.

When the Vibration Programmer is not used, as in Fig. 9.3, only two frequency sub-ranges are possible and the cross-over is achieved with a relay in the Vibration Meter, controlled by a switch on the sweep mechanism of the Automatic Vibration Exciter Control. The cross-over may be from "Displacement" to "Acceleration", from "Velocity" to "Acceleration" or from "Acceleration" to "Acceleration Gradient". The remaining possible combinations of two functions are obtained by short-circuiting appropriate sockets at the back of the Vibration Meter.

The vibration level is controlled by the level potentiometers of the Vibration Meter whose potentiometers act as external potentiometers for the Control Signal Selector irrespective of which channel is selected, as the control signals to the Selector are taken out before the potentiometers.

III.

Leaving out the Control Signal Selector as shown in Fig. 9.4, results in a system which has five cross-over frequencies, but which employs only one control accelerometer at any one time. The Preamplifier Type 2622 has two channels, so that two accelerometers may be connected, and a switch-over



from one to the other can be done automatically at some pre-selected frequency, for example by using the generator switching at 30 – 100 – 300 Hz, or the "cross-over" switch.

9.6. Operation.

1. Connect the instruments as indicated by the relevant figure. Make sure that the voltage selector at the back of each instrument is in the correct position.
2. Turn all level controls and the Generator OUTPUT VOLTAGE to zero.
3. Switch on the power and allow five minutes warm-up time.
4. Set the FUNCTION SELECTOR and meter range switches of the Vibration Meters to suitable positions.
5. Tap the accelerometers gently and see that the vibration signals show up on the Vibration Meters.
6. Calibrate the frequency scale of the generator as described in its instruction manual. Set the cross-over frequencies to the required positions. (Set the cross-over on the Generator outside the frequency range if the Vibration Programmer is used). Set the frequency pointer somewhere in the range which is going to be used for the test.
7. If the Control Signal Selector is employed, set to "Highest".
8. Set the COMPRESSOR switch of the Generator to the desired position (not "Off").
9. Turn up the OUTPUT VOLTAGE of the Generator very slowly and see that the compressor loop suppresses the vibration amplitude. The deflection on the relevant Vibration Meter for Generator OUTPUT VOLTAGE turned fully on should be less than about 0.1 times full deflection. If the vibration amplitude is excessive, turn the OUTPUT VOLTAGE to zero again and locate the cause.
10. If the compressor loop is working properly, set the Control Signal Selector and the remaining control switches to the required positions whereby the testing may be started.

In combinations using the Control Signal Selector it should be noted that the FUNCTION SELECTOR of the Vibration Meter is set to "Auto" whereby the FUNCTION SELECTOR and the VIBRATION LEVEL potentiometers of the Vibration Meter are substituted by the corresponding knobs of the Control Signal Selector.

WARNING

When the red DANGER lamp is alight, the knobs with red spots must not be touched by unauthorized personnel, otherwise permanent damage may be caused to the specimen and shaker table.

10. Combinations With Generator Type 1008

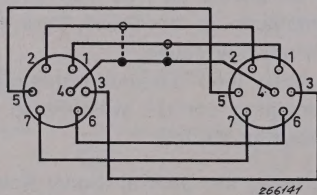
10.1. Cables and Interconnections.

The Automatic Vibration Exciter Control Type 1008 is a combination of a sine generator and a vibration meter, so that basically the Vibration Meter Type 2502 is not necessary for its operation. It may be desirable however, to use the four-accelerometer control and the five cross-over frequencies provided by the Control Signal Selector and the Vibration Programmer. It is then necessary to include 2502 in the system and to bypass the vibration meter section of 1008. When this is done two positions of the generator METER SWITCH cannot be used, viz. the "Vibration Level" and the "Vibration Level Preset".

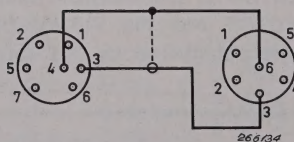
In the following the various combinations are shown schematically, and their main features are outlined. Diagrams of the relevant connecting cables are also given, to facilitate interconnection of the instruments.

The following cables are used:

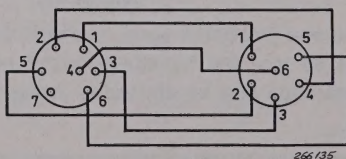
Standard



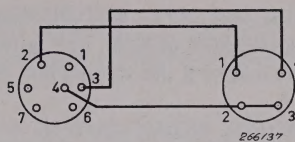
Type A



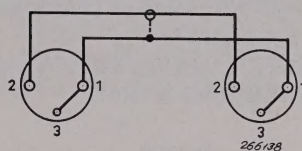
Type B



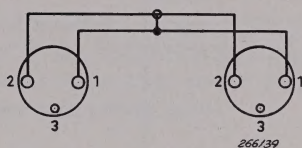
Type D



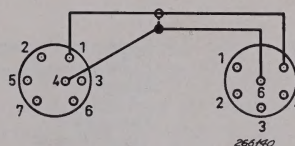
Type E



Type F



Type G



In order to simplify the illustrations somewhat, the power amplifier, shaker, test specimen and accelerometers are left out in the following combinations. (A complete system was shown in Fig. 2.1).

The cable connections in the illustrations are labelled, the upper half of the circles indicating the type of cable, and the lower half indicating the connection of the cable in accordance with the following table:

1. From DC OUTPUT of 2502 to CHANNEL INPUT of 4410.
2. From COMPRESSOR VOLTAGE of 4410 to COMPRESSOR of 1008. The short-circuiting link between pins 2 and 3 in the COMPRESSOR socket of 1008 to be removed.
3. From VIBRATION LEVEL POTENTIOMETERS of 4410 to VIBRATION LEVEL POTENTIOMETERS of 4411.
4. From REMOTE FUNCTION SELECTOR of 4411 to REMOTE FUNCTION SELECTOR of 2502, via a connection box if there is more than one 2502.
5. From the pilot voltage output socket of 1008 to PILOT VOLTAGE of 4411.
6. From RELAY CONTROL B of 1008 to RELAY CONTROL of 2502, via a connection box if there is more than one 2502.
7. From OUTPUT A or OUTPUT B of 2622 to ACCELERATION INPUT of 2502. In order to avoid ground loops the accelerometers should be isolated from ground and each Preamplifier Type 2622 should only be grounded at one point. One E cable and one F cable are therefore used for each pre-amplifier as shown in the figures.

8. From VIBRATION LEVEL POTENTIOMETERS of 4410 to VIBRATION LEVEL POTENTIOMETERS of 2502. The connection between pins 1 and 3 in 2502 to be removed, and the connection between pins 1 and 7 to be changed to 3 and 7.
9. From CONTROL SIGNAL OUTPUT of 4411 to COMPRESSOR of 1008. The short circuit link between pins 5 and 1 in the COMPRESSOR socket of 1008 to be removed.
10. From VIBRATION LEVEL POTENTIOMETERS of 2502 to VIBRATION LEVEL POTENTIOMETERS of 4411.

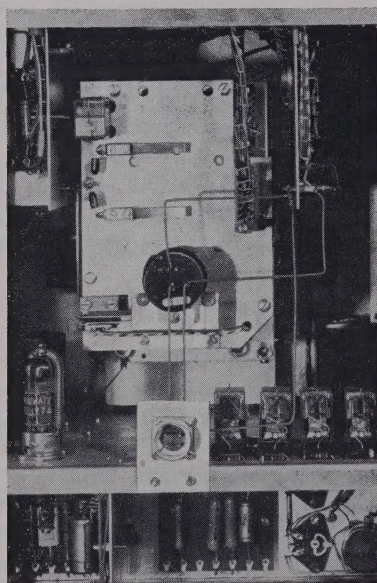
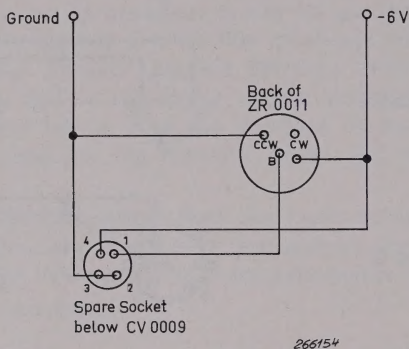


Fig. 10.1. Connection of the potentiometer ZR 0011 for the pilot voltage.

Standard Cables (AO 0058) 2 m long and Connection Boxes (JJ 0036) for parallel connection of 5 Standard Cables are available on request.

10.2. Pilot Voltage.

The frequency dependent DC voltage for control of the Vibration Programmer is obtained by fixing a potentiometer ZR 0011 to the sweep mechanism at the back of the Vibration Exciter Control. This potentiometer is connected to the socket just below the sweep mechanism as shown in Fig. 10.1.

10.3. Modification to Generator.

When connecting up the 1008 in combinations I and II below, the short-circuiting link between pins 2 and 3 of the COMPRESSOR socket should be removed. For combination III the connection between pins 1 and 5 should be removed while that between pins 2 and 3 should be kept.

10.4. Modification to Vibration Meter.

For Combination II the short-circuiting link between pins 1 and 3 in the VIBRATION LEVEL POTENTIOMETERS socket of the Vibration Meter whose potentiometers are used as external potentiometers for the Control Selector should be removed, and the connection between pins 1 and 7 should be changed to 3 and 7.

10.5. Combinations.

I.
Fig. 10.2 shows a system which utilizes the whole instrument range. There are four control accelerometers, two 2-channel preamplifiers and four Vibration Meters. Thus the vibration is controlled at up to four positions and the frequency range is split up into six subranges with individual function and level control.

II.
When the Vibration Programmer is not used, as in Fig. 10.3, only two frequency sub-ranges are possible and the cross-over is achieved with a relay in the Vibration Meter, controlled by a switch on the sweep mechanism of the Automatic Vibration Exciter Control. The cross-over may be from "Displacement" to "Acceleration", from "Velocity" to "Acceleration" or from "Acceleration" to "Acceleration Gradient". The remaining possible combinations of two functions are obtained by short-circuiting appropriate sockets at the back of the Vibration Meter.

The vibration level is controlled by the level potentiometers of the Vibration Meter whose potentiometers act as external potentiometers for the Control Signal Selector irrespective of which channel is selected, as the control signals to the Selector are taken out before the potentiometers.

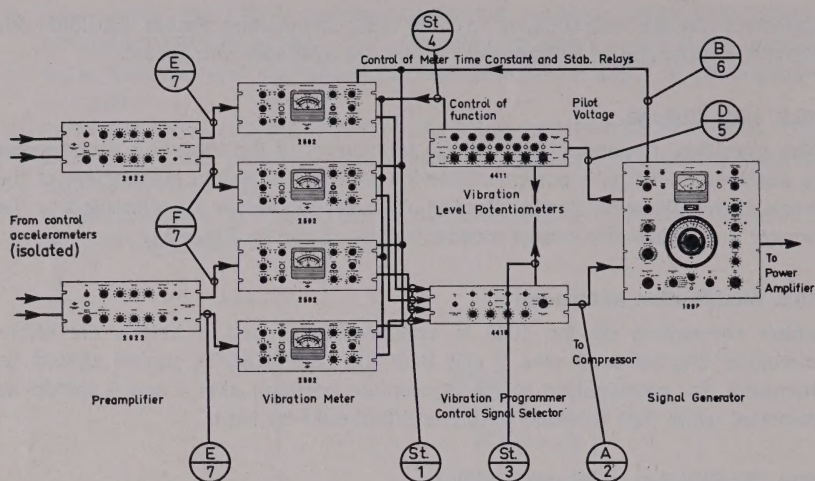


Fig. 10.2. Combination I.

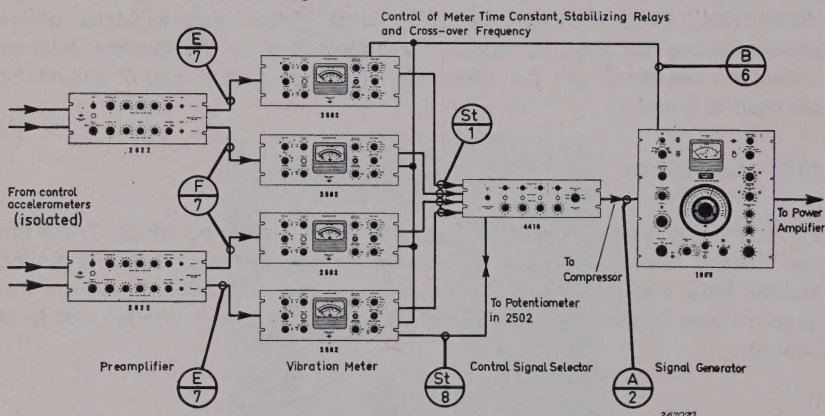


Fig. 10.3. Combination II.

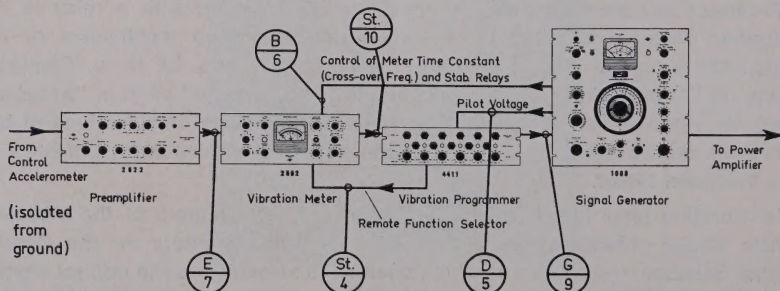


Fig. 10.4. Combination III.

III.

Leaving out the Control Signal Selector as shown in Fig. 10.4, results in a system which has five cross-over frequencies, but which employs only one control accelerometer at any one time. The Preamplifier Type 2622 has two channels, so that two accelerometers may be connected, and a switch-over from one to the other can be done automatically at some pre-selected frequency, for example by using the generator switching at 30 – 100 – 300 Hz, or the "cross-over" switch.

10.6. Operation.

1. Connect the instruments as indicated by the relevant figure. Make sure that the voltage selector at the back of each instrument is in the correct position.
2. Turn all level controls and the Generator OUTPUT VOLTAGE to zero.
3. Switch on the power and allow five minutes warm-up time.
4. Set the FUNCTION SELECTOR and meter range switches of the Vibration Meters to suitable positions.
5. Tap the accelerometers gently and see that the vibration signals show up on the Vibration Meters.
6. Calibrate the frequency scale of the generator as described in its instruction manual. Set the cross-over frequencies to the required positions. (Set the cross-over on the Generator outside the frequency range if the Vibration Programmer is used). Set the frequency pointer somewhere in the range which is going to be used for the test.
7. If the Control Signal Selector is employed, set to "Highest".
8. Set the COMPRESSOR switch of the Generator to the desired position (not "Off").
9. Turn up the OUTPUT VOLTAGE of the Generator very slowly and see that the compressor loop suppresses the vibration amplitude. The deflection on the relevant Vibration Meter for Generator OUTPUT VOLTAGE turned fully on should be less than about 0.1 times full deflection. If the vibration amplitude is excessive, turn the OUTPUT VOLTAGE to zero again and locate the cause.
10. If the compressor loop is working properly, set the Control Signal Selector and the remaining control switches to the required positions whereby the testing may be started.
11. The OUTPUT VOLTAGE control of the Generator should be adjusted so that minimum compression during sweep is in the vicinity of 0 dB but not less. The amount of compression can be read on the COMPRESSOR METER of the Automatic Vibration Exciter Control.

In combinations using the Control Signal Selector it should be noted that the FUNCTION SELECTOR of the Vibration Meter is set to "Auto" whereby the

FUNCTION SELECTOR and the VIBRATION LEVEL potentiometers of the Vibration Meter are substituted by the corresponding knobs of the Control Signal Selector.

WARNING

When the red DANGER lamp is alight, the knobs with red spots must not be touched by unauthorized personnel, otherwise permanent damage may be caused to the specimen and shaker table.

11. Combinations With Generator Type 1025

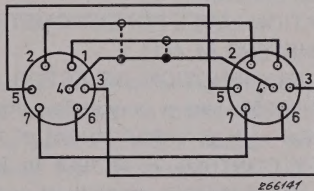
11.1. Cables and Interconnections.

The Automatic Vibration Exciter Control Type 1025 is a combination of a sine generator and a vibration meter, so that basically the Vibration Meter Type 2502 is not necessary for its operation. It may be desirable however, to use the four-accelerometer control and the five cross-over frequencies provided by the Control Signal Selector and the Vibration Programmer. It is then necessary to include 2502 in the system and to bypass the vibration meter section of 1025. When this is done two positions of the generator METER SWITCH cannot be used, viz. the "Vibration Level" and the "Vibration Level Preset".

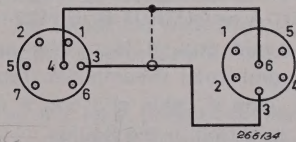
In the following the various combinations are shown schematically, and their main features are outlined. Diagrams of the relevant connecting cables are also given, to facilitate interconnection of the instruments.

The following cables are used:

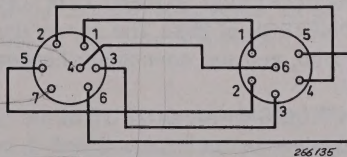
Standard



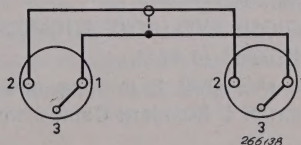
Type A



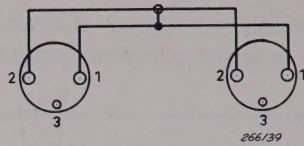
Type B



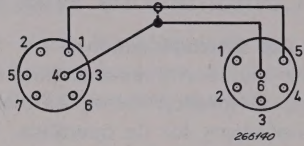
Type E



Type F



Type G



In order to simplify the illustrations somewhat, the power amplifier, shaker, test specimen and accelerometers are left out in the following combinations. (A complete system was shown in Fig. 2.1).

The cable connections in the illustrations are labelled, the upper half of the circles indicating the type of cable, and the lower half indicating the connection of the cable in accordance with the following table:

1. From DC OUTPUT of 2502 to CHANNEL INPUT of 4410.
2. From COMPRESSOR VOLTAGE of 4410 to COMPRESSOR of 1025. The short-circuiting link between pins 2 and 3 in the COMPRESSOR socket of 1025 to be removed.
3. From VIBRATION LEVEL POTENTIOMETERS of 4410 to VIBRATION LEVEL POTENTIOMETERS of 4411.
4. From REMOTE FUNCTION SELECTOR of 4411 to REMOTE FUNCTION SELECTOR of 2502, via a connection box if there is more than one 2502.
5. From the pilot voltage output socket of 1025 to PILOT VOLTAGE of 4411.
6. From RELAY CONTROL B of 1025 to RELAY CONTROL of 2502, via a connection box if there is more than one 2502.
7. From OUTPUT A or OUTPUT B of 2622 to ACCELERATION INPUT of 2502. In order to avoid ground loops the accelerometers should be isolated from ground and each Preamplifier Type 2622 should only be grounded at one point. One E cable and one F cable are therefore used for each preamplifier as shown in the figures.
8. From VIBRATION LEVEL POTENTIOMETERS of 4410 to VIBRATION LEVEL POTENTIOMETERS of 2502. The connection between pins 1 and 3 in 2502 to be removed, and the connection between pins 1 and 7 to be changed to 3 and 7.
9. From CONTROL SIGNAL OUTPUT of 4411 to COMPRESSOR of 1025. The short circuit link between pins 5 and 1 in the COMPRESSOR socket of 1025 to be removed.
10. From VIBRATION LEVEL POTENTIOMETERS of 2502 to VIBRATION LEVEL POTENTIOMETERS of 4411.

Standard Cables (AO 0058) 2 m long and Connection Boxes (JJ 0036) for parallel connection of 5 Standard Cables are available on request.

11.2. Modification to Generator.

When connecting up the 1025 in combinations I and II below, the short-circuiting link between pins 2 and 3 of the COMPRESSOR socket should be removed. For combination III the connection between pins 1 and 5 should be removed while that between pins 2 and 3 should be kept.

11.3. Modification to Vibration Meter.

For Combination II the short-circuiting link between pins 1 and 3 in the VIBRATION LEVEL POTENTIOMETERS socket of the Vibration Meter whose potentiometers are used as external potentiometers for the Control Selector should be removed, and the connection between pins 1 and 7 should be changed to 3 and 7.

11.4. Combinations.

I.

Fig. 11.1 shows a system which utilizes the whole instrument range. There are four control accelerometers, two 2-channel preamplifiers and four Vibration Meters. Thus the vibration is controlled at up to four positions and the frequency range is split up into six subranges with individual function and level control.

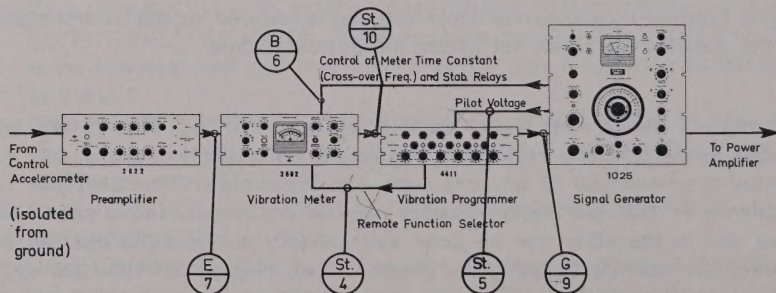
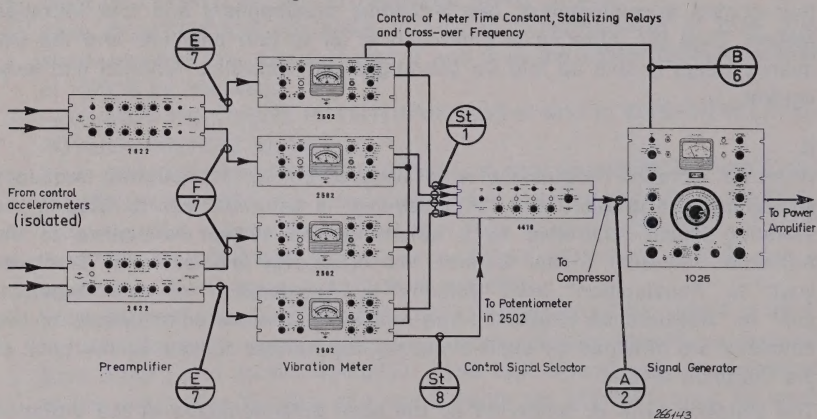
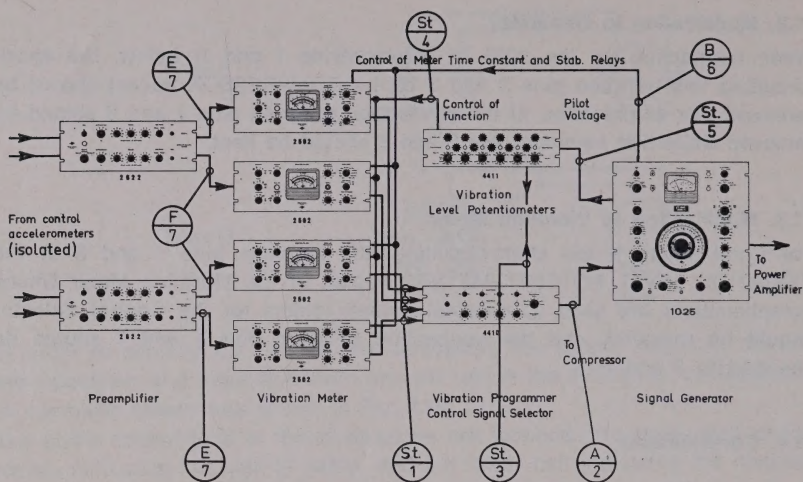
II.

When the Vibration Programmer is not used, as in Fig. 11.2, only two frequency sub-ranges are possible and the cross-over is achieved with a relay in the Vibration Meter, controlled by a switch on the sweep mechanism of the Automatic Vibration Exciter Control. The cross-over may be from "Displacement" to "Acceleration", from "Velocity" to "Acceleration" or from "Acceleration" to "Acceleration Gradient". The remaining possible combinations of two functions are obtained by short-circuiting appropriate sockets at the back of the Vibration Meter.

The vibration level is controlled by the level potentiometers of the Vibration Meter whose potentiometers act as external potentiometers for the Control Signal Selector irrespective of which channel is selected, as the control signals to the Selector are taken out before the potentiometers.

III.

Leaving out the Control Signal Selector as shown in Fig. 11.3, results in a system which has five cross-over frequencies, but which employs only one control accelerometer at any one time. The Preamplifier Type 2622 has two channels, so that two accelerometers may be connected, and a switch-over from one to the other can be done automatically at some pre-selected frequency, for example by using the generator switching at 30–100–300 Hz, or the "cross-over" switch.



11.5. Operation.

1. Connect the instruments as indicated by the relevant figure. Make sure that the voltage selector at the back of each instrument is in the correct position.
2. Turn all level controls and the Generator OUTPUT VOLTAGE to zero.
3. Switch on the power and allow five minutes warm-up time.
4. Set the FUNCTION SELECTOR and meter range switches of the Vibration Meters to suitable positions.
5. Tap the accelerometers gently and see that the vibration signals show up on the Vibration Meters.
6. Calibrate the frequency scale of the generator as described in its instruction manual. Set the cross-over frequencies to the required positions. (Set the cross-over on the Generator outside the frequency range if the Vibration Programmer is used). Set the frequency pointer somewhere in the range which is going to be used for the test.
7. If the Control Signal Selector is employed, set to "Highest".
8. Set the COMPRESSOR switch of the Generator to the desired position (not "Off").
9. Turn up the OUTPUT VOLTAGE of the Generator very slowly and see that the compressor loop suppresses the vibration amplitude. The deflection on the relevant Vibration Meter for Generator OUTPUT VOLTAGE turned fully on should be less than about 0.1 times full deflection. If the vibration amplitude is excessive, turn the OUTPUT VOLTAGE to zero again and locate the cause.
10. If the compressor loop is working properly, set the Control Signal Selector and the remaining control switches to the required positions whereby the testing may be started.
11. The OUTPUT VOLTAGE control of the Generator should be adjusted so that minimum compression during sweep is in the vicinity of 0 dB but not less. The amount of compression can be read on the COMPRESSOR METER of the Automatic Vibration Exciter Control.

In combinations using the Control Signal Selector it should be noted that the FUNCTION SELECTOR of the Vibration Meter is set to "Auto" whereby the FUNCTION SELECTOR and the VIBRATION LEVEL potentiometers of the Vibration Meter are substituted by the corresponding knobs of the Control Signal Selector.

WARNING

When the red DANGER lamp is alight, the knobs with red spots must not be touched by unauthorized personnel, otherwise permanent damage may be caused to the specimen and shaker table.

12. Specifications

12.1. Vibration Meter Type 2502.

Functions.

The Vibration Meter can measure displacement, velocity, acceleration and acceleration gradient when fed with an acceleration signal.

It also measures acceleration density when fed with an acceleration density signal from a power spectral density analyzer.

The following tolerances are applicable:

Quantity	Level Range	$\pm 4\%$ in range (Hz)	Approx. 5 % down at, (Hz)
Displacement (in) (mm)	0.001 – 0.01 0.025 – 0.25	100– 2000	50
Peak-Peak and RMS	0.01 – 0.1 0.25 – 2.5 0.1 – 10 2.5 – 250	10– 2000 10– 500	5 5
Velocity (in/sec) (m/sec)	0.01 – 0.1 0.00025– 0.0025	100– 2000	50
Peak and RMS	0.1 – 100 0.0025 – 2.5	10– 2000	5
Acceleration (g)	0.1 – 1000	10– 10000	5
Acceleration Gradient (g $\sqrt{\text{sec}}$)	0.001 – 10	10– 10000 ($\pm 5\%$)	
Acceleration Density (g ² /cps)	0.0001 – 100	10– 100000	

Inputs.

One for acceleration signals scaled to 10 mV/g. Input impedance 50 kohm.

One for acceleration density signal scaled to 1 Volt per g²/cps. Input impedance 20 kohm.

Outputs.

"Monitor" jack in the front panel. A load of 15 kohm (Level Recorder Type 2305) gives less than 1 % error on the meter indication. The output is approximately 10 volts for full scale deflection on the meter. Output impedance appr. 15 kohm.

"Vibration Potentiometers". For interconnection of level potentiometers in 2502 and the compressor amplifiers in the Control Signal Selector Type 4410.

"Control Signal Output". AC signal to the compressor input of the Vibration Generator.

"DC-Output". Negative, smoothed DC from meter circuit, -6.5 V for full scale deflection. Tolerance: $\pm 1\%$ from 20 dB below to 10 dB above full deflection. Min. load impedance 10 kohm.

Other Terminals.

Terminals for external filter.

Output impedance of preamplifier 100 ohms. Input impedance of output amplifier 1000 kohms.

Max. output voltage from preamplifier 30 volts across 20 kohm.

"Relay Control" for stabilizing networks (low frequency cut-off) and cross-over frequency controlled by signal generator.

"Remote Function Selector" for remote control of mode of operation, from the Vibration Programmer Type 4411.

Cross-over.

Automatic cross-over from "Displacement" to "Acceleration", from "Velocity" to "Acceleration" and from "Acceleration" to "Acceleration Gradient" governed by cross-over switch in a B & K Vibration Generator. Any other combination of two functions may be obtained by appropriate short-circuiting between "Relay Control" and "Cross-over" terminals.

Up to five cross-overs with any combination of functions including external filter including a 20 dB increase in level in each subrange, operated from the Vibration Programmer Type 4411.

Meter Circuit.

Quasi-RMS full-wave rectifier with RMS indication of sinusoidal signals and white noise. Peak or peak-to-peak values measured by $\sqrt{2}$ and $\sqrt{8}$ times increase in sensitivity.

Moving coil instrument with semi-logarithmic, mirrored scale. Ribbon suspension and full protection against overload.

Meter Time Constants 0.3 – 1 – 3 – 10 and 30 seconds plus 4 automatic programs operated from a B & K Vibration Generator as tabulated below.

Freq. Range (Hz)	Meter Time Constant (sec)			
Below 30	10	30	30	30
30– 100	3	10	30	30
100– 300	1	3	10	30
300–1000	0.3	1	3	10
Above 1000	0.3	0.3	1	3

Stability.

The tolerances specified are valid after a warm-up period of 5 minutes, with variations of $\pm 10\%$ in the mains voltage.

The Vibration Meter is operable for variations in mains voltage up to $\pm 15\%$.

Mains Voltage.

100 – 115 – 127 – 150 – 220 and 240 Volt, 50–400 Hz. Consumption 55 Watt.

Type	Width	Height	Depth	Weight
2502 B (Mahogany Cabinet)	51 cm 20 in	21 cm 8 in	33 cm 13 in	12.5 kg 27 lbs
2502 C (for 19" rack)	48 cm 19 in	18 cm 7 in	27 cm 10.5 in	9.2 kg 20 lbs

Accessories Included.

- 1 power cable
- 1 Cannon WK-C3-21C (JP 0304)
- 4 Cannon WK-A7-21C (JP 0700)
- Various panel lamps and fuses

Extra Accessories see page 68.

12.2. Control Signal Selector Type 4410.**Inputs.**

Unsmoothed DC from 2502: Max. 28 V peak 5 kHz in position "Average". Max. 13 V peak 10 kHz in "Channel 1 – 2 – 3 – 4" and "Lowest" or "Highest". Input impedance 5 Mohm.

Smoothed DC for comparators: Max. 11 V, min. 600 mV with attenuators in position 0 dB (600 mV represents 0 dB deflection on the indicating meter of 2502). Input impedance 5 kohm.

Tolerances (to 40° C ambient temperature).

"Average", 1 %

"Highest" or "Lowest", 2 % $\pm$ 6 mV

Attenuators, $\pm 1\%$

Stability, $\pm 1\%$ per amplifier.

Mains Voltage.

100 – 115 – 127 – 150 – 220 or 240 V, 50–400 Hz.

Type	Width	Height	Depth	Weight
4410 B (Mahogany Cabinet)	51 cm 20 in	16 cm 6 in	20 cm 8 in	5.5 kg 12 lbs
4410 C (for 19" rack)	48 cm 19 in	13 cm 5 in	16 cm 6 in	3.7 kg 8 lbs

Accessories Included.

- 1 power cable
- 6 Cannon WK-A7-21C (JP 0700)
- Various panel lamps and fuses

Extra Accessories see page 68.

12.3. Vibration Programmer Type 4411.

Frequency Response.

2Hz–10 kHz, $\pm 2\%$.

Cross-over Hysteresis.

6 mV, corresponding to less than 1% of the frequency when connected to a B & K Vibration Generator. Stability, 6 mV for ambient temperatures up to 40°C.

Max. Output.

6 V peak AC.

Mains Voltage.

100 – 115 – 127 – 150 – 220 or 240 V, 50–400 Hz.

A maximum number of four Vibration Meters Type 2502 may be controlled from 4411.

Type	Width	Height	Depth	Weight
4411 B (Mahogany Cabinet)	51 cm 20 in	16 cm 6 in	20 cm 8 in	6 kg 13 lbs
4411 C (for 19" rack)	48 cm 19 in	13 cm 5 in	16 cm 6 in	4.5 kg 9 lbs

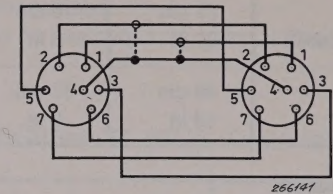
Accessories Included.

- 1 power cable
- 4 Cannon WK-A7-21C (JP 0700)
- Various panel lamps and fuses

Extra Accessories Available

AO 0058, Standard Cable. Length 2 m.

Standard



JJ 0036, Connection Box for Standard Cables.
5 parallel connected 7-pin sockets (Cannon WK-A7-32S)
in metal casing.

